With the compliments of the author.

E. W. Butler

Notes on the Japanese Fungi.

I. UREDINEÆ ON SOPHORA.

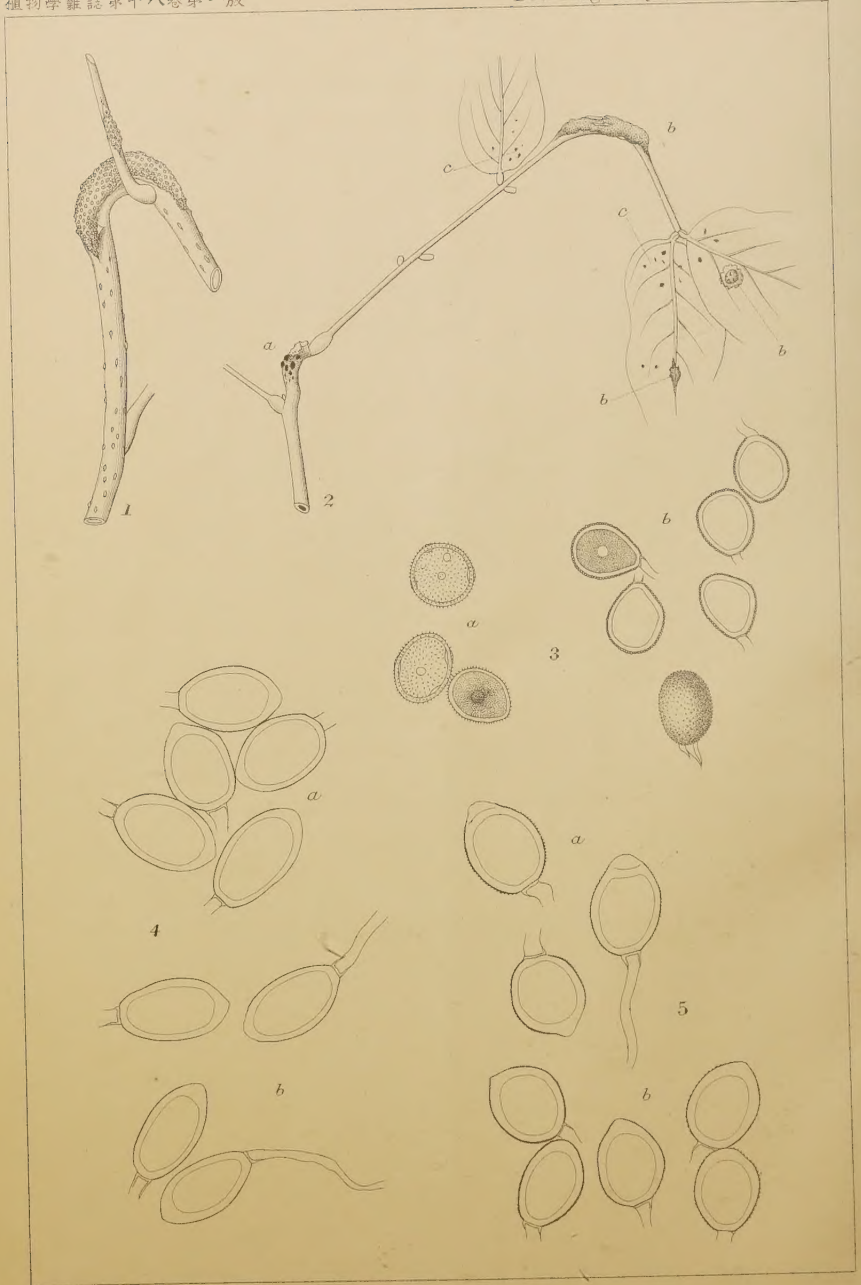
BY

S. Kusano.

With Plate I.

[*Reprinted from Bot. Mag., Tokyo, Vol. XVIII. No. 203*].

1904.



S. Kusano del.

Uredineae on Sophora.

Notes on the Japanese Fungi.

I. UREDINEÆ ON SOPHORA.

BY

S. Kusano.

With Plate I.

Uromyces truncicola P. Henn. et Shir.

(Engl. bot. Jahrb. XXVIII. 1900. p. 260) (Figs. 2. 4).

Sophora japonica is very often attacked by two kinds of *Uromyces*, of which *Uromyces truncicola, cause of the canker growth of the tree,* ultimately brings it to destruction. So far as my observations go, no older stock of this tree has ever been found in Tokyo till now, whose stems or branches are entirely free from this dangerous fungus. Any old tree carries generally several hundreds of cankers, small or large according to the size of stems or branches on which they occur. Branches once attacked by this fungus are gradually destroyed by various causes which may fall upon them during long intervals of their growth. It is surely due to this reason that the old trees cultivated in the Botanic Garden of Tokyo and Komaba (10 in number), having lost the greater part of their crown, are now gradually approaching to death.

When young, a canker produces every year on its peripheral portion a large mass of teleutospores, which, forming large irregular sori, upheaves the overlying bark and bursts out from the fissure of it.[1] The spores are easily swept away by rain or dew, so that they are found finally only along the under side of each branch, forming a thick, black to brownish coating. They germinate in the next spring and produce numerous sporidia, which infect immediately the young stem, causing a slight thickening and discolouration around the infected point: this constitutes the primary generation of the fungus (Fig. 2 a). At first, appear in this place numerous pycnidia which are replaced soon after by aggergated teleutosori of small size.[2] With the growth of the stem the intercellular mycelium spreads here and there, and giving rise to the abnormal growth, especially of the cortex, causes the spindle-shaped canker. The teleutosori are formed

1. In an old canker the fungus remains sterile.
2. On this account the fungus may be included to *Microuromyces.*

primarily under the epidermis of the stem, but those which appear on the same place in the succeeding years seem to be formed under some few layers of the cortical parenchyma to a considerable extent.

The most characteristic feature which reveals at once the presence of the fungus even to the naked eyes is that *the cortical parenchyma is coloured yellow wherever intercellular mycelium spreads out.*

Uromyces Sophoræ japonicæ Diet.

(Engl. bot. Jahrb. XXXII. 1902. p. 47) (Figs. 2. 5).

This is another kind of *Uromyces* occurring on *Sophora japonica*, together with *U. truncicola*. It differs, however, from the latter by the fact that it occurs not on the stem of the host but always on *foliar organs*, especially on the blade, apparently with no harm to the host.

The infection of this fungus takes place at first in spring on the blade of a young leaf, where the fungus forms pale yellowish spots, each 3–4 mm. in diameter; the blade then increases very slightly in thickness in those places (see Fig. 2). The infection may take place also on the petiole of the compound leaf, in which case it induces a local hypertrophy (as we have seen in the case of *Uromyces truncicola*), whereby the petiole is distorted in various ways (Fig. 2 b). After some time uredosori are formed in these spots being preceded or accompanied by pycnidia. At first the uredosori develope as brownish spots on the affected place, but on the petiole they become later fused together apparently and make the whole surface of that place pulverulent. Teleutospores may sometimes occur on these sori.

In general, primarily affected parts perish after some time, so that they appear as brownish dried spots on adult leaves.

The uredospores of the primary generation give rise to the next generation in the other places, generally of the blade, causing in this case no apparent change to the host. Sori formed there are small and irregularly scattered, and show no aggregation as before (Fig. 2 c). After many generations of the uredospores were produced, the fungus comes to extend over a certain area of adult leaves. From the beginning of autumn teleutospores may be seen either in the uredosori or elsewhere. The teleutosori are also exceedingly small and form merely black specks, which are composed generally of a very small number of spores. In their general form, size and some other respects the teleutospores resemble very much those of

Uromyces truncicola. Only the verrucose thickening of the wall of the spore of the present species, which might, however, be overlooked sometimes under low power of microscope, is of much diagnostic value.

The teleutospores germinate in the next spring and the sporidia produced on them will certainly effect the primary infection on the host forming the diseased spot as has been stated above. Hence the present species belongs to *Brachyuromyces.*

Since these two *Uromyces* are found together on the same plant and produce also similar teleutospores hardly distinguishable from each other at the glance, and since the mode of infection is nearly the same in both, it will scarcely possible to determine them, if their life history were quite unknown. So the followings are necessary for their distinction :—

Uromyces truncicola.	*Uromyces Sophoræ japonicæ.*
1. It belongs to *Microuromyces,* perennial in the cortex.	It belongs to *Brachyuromyces.*
2. The primary infection takes place on the stem of a young shoot which suffers a slight hypertrophy and becomes pale yellow.	The primary infection takes place on the petiole or blade of a young leaf, where it causes an hypertrophy and discolouration as in *U. truncicola.*
3. The point of primary infection is permanently inhabited by the fungus producing annually teleutospores.	The point of primary infection is temporarily inhabited by the fungus, it perishes soon after, and the fungus comes to develope on the other places, generation after generation.
4. A typical teleutospore is subglobose, obtuse at the apex, somewhat narrows towards the base. It is chestnut brown.	A typical teleutospore is globose or ovoid, pointed at the apex with a conical thickening of the wall, rounded at the base. It is dark chestnut brown.
5. It measures more than 40 μ in length and less than 25–26 μ in breadth. See the following :—	It measures less than 40 μ in length and more than 25–26 μ in breadth. See the following :—

On the tree A (23. Nov. 1903, Bot. Gard., Tokyo) (Fig. 4 a).

40 × 29 μ	40 × 26 μ
41 × 27	40 × 26
40 × 27	44 × 25
40 × 25	40 × 25
44 × 25	40 × 25
40 × 25	40 × 25
41 × 26	40 × 27.
40 × 25	

On the tree B (20. Nov. 1903, Bot. Gard., Tokyo) (Fig. 4 b).

33 × 25 μ	38 × 26 μ
38 × 23	40 × 23
42 × 22	36 × 23
45 × 26	42 × 22
46 × 25	27 × 25
43 × 23	40 × 22.
42 × 22	

6. The wall of the teleutospore is *smooth*.
7. The pedicel of the teleutospore is thin walled, hyaline, 60 μ in length.

On the tree A (Oct. 1901, Bot. Gard., Tokyo) (Fig. 5 a).

45 × 25 μ	38 × 27 μ
38 × 27	35 × 30
38 × 23	35 × 30
40 × 24	36 × 26.
36 × 24	
32 × 27	
38 × 29	
38 × 27	

On the tree B (20. Nov. 1903, Bot. Gard., Tokyo) (Fig. 5 b).

35 × 25 μ	37 × 26 μ
37 × 22	34 × 25
41 × 22	35 × 26
37 × 23	35 × 22
35 × 26	33 × 25
32 × 25	37 × 23
35 × 26	34 × 25.

The wall of the teleutospore is irregularly and minutely *verrucose*
The pedicel of the teleutospore is thin walled, hyaline, 60 μ in length.

From above, we see that the presence or absence of uredospores and the character of the wall of teleutospores are the most important points which characterize the species concerned.

Uromyces Sophoræ flavescentis Kus. n. sp.

(Fig. 3).

Uredosori hypophyllous, indefinitely scattered, irregular in form and size, reddish orange, pulverulent, without paraphyses; spores globose, subglobose or obovoid, coarsely echinulate on the surface of the thin wall, contents orange, 20–25 or 26 × 22 μ, pores 7–8 (Fig. 3 a).

Teleutosori hypophyllous, isolate, indefinitely scattered or arranged circularly, placed either in uredosori or outside of them, irregular in form and size like uredosori, attaining to 1 mm. in diameter, sometimes confluent,

black to dark brownish; spores irregular, obovoid or rarely subglobose, angular from compression, wall thin, verrucose, dark brownish, 22–28 × 20–22 μ (Fig. 3 b).

On *Sophora flavescens* Ait. var. *galegoides* Hemsl. September 10. 1900 and October 1903, Botanic Garden of Tokyo (S. Kusano).

The formation of the teleutospore begins in September and attains its maximum in October. Uredospores seem to precede it and to be formed generally in August or earlier. But on the young shoot they can be found sometimes vigorously developing even at the end of October. This fungus occurs annually on the same stock of this perennial herb which is cultivated in the Botanic Garden of Tokyo. It is found spreading over the whole plant and over the whole surface of the leaf, forming uredo and teleutosori densely. I did not yet observed the first infection of the fungus and am not sure whether the fungus belongs to *Hemiuromyces* or *Brachyuromyces*. But the presence of some brownish dead spots on the leaves, with some trace of the old sori, like those of *Sophora japonica*, which are due to the primary uredosori of its own *Uromyces* (*U. Sophoræ japonicæ*) makes certain that they may be the point of primary infection, on which pycnidia preceded uredosori. Whence we include the fungus provisionally to *Brachyuromyces*.

Aecidium Sophoræ Kus. n. sp.

(Fig. 1).

Pycnidia preceding or accompanying aecidia, amphigenous, chiefly epiphyllous, punctate, with hair-like bristles of hyphæ at the aperture; spores elliptical or globose, hyaline.

Aecidia amphigenous, chiefly hypophyllous and also on petiole and stem, in indefinite and irregular clusters, often covering the greater part of the leaf; pseudoperidia aggregate, sub-circinating, small, shallow, border narrow, coarsely lacerate and recurved; cells rectangular, in one layer, 40–50 × 20–25 μ, wall smooth; spores subglobose, somewhat angular from compression, epispore thin, minutely verrucose, 25-35 × 16-22 μ.

On *Sophora platycarpa* Maxim. June 7. 1900, Hakone in Prov. Sagami (Prof. J. Matsumura).

This fungus occurs usually on petioles and midribs, and extends along or around them to a certain extent, causing to the substratum a moderate

thickening. When it occurs on the midribs or veins, the blade is distorted in various ways. On the young stem it forms the cluster of aecidia on one side of it, more than 20 mm. long, in which case a considerable curvature may be caused, accompanied by an abnormal thickening on the convex side (Fig. 1). When they once attacked by this fungus, the annual growth of its branches and stems seems to be certainly greatly checked.

Botanical Laboratory, Imperial University, Tokyo.

EXPLANATION OF FIGURES IN PLATE I.

Fig. 1. One year old branch of *Sophora platycarpa* with a cluster of the aecidia of *Aecidium Sophoræ*. Nat. size.

Fig. 2. One year old branch of *Sophora japonica*. *a*, primary sori of *Uromyces truncicola*. *b*, primary uredosori of *Uromyces Sophoræ japonicæ*. *c*, secondary uredosori of the same. Nat. size.

Fig. 3. *Uromyces Sophoræ flavescentis*. *a*, uredospores. *b*, teleutospores. × 400.

Fig. 4. *Uromyces truncicola*. *a*, teleutospores from tree *A*. *b*, teleutospores from tree *B*. × 400.

Fig. 5. *Uromyces Sophoræ japonicæ*. *a*, teleutospores from tree *A*. *b*, teleutospores from tree *B*. × 400.

[Reprinted from Bot. Mag. Tokyo. XVIII. 1904.]

Notes on the Japanese Fungi.

II. SOME SPECIES OF UREDINEÆ.

BY

S. Kusano. ~~n. sp.~~

Puccinia Cacaliæ Kusano. n. sp.

Teleutosori hypophyllous, isolate, irregular, 1–½ mm. in diameter, naked, pulverulent, black; spores oblong or fusiform, slightly rounded at the upper end, mostly tapering towards the lower end, constricted at the septum, with upper cell broader than the lower, wall thickened at the apex, forming conical papilla (15 μ), smooth, brown, 55–63 × 18–23 μ; ~~spores with longer~~ pedicel short, hyaline or pale.

On the leaves of *Cacalia Syncilesis* (Fr. et Sav.) (=*Senecio Syncilesis* Fr. et Sav). Aug. 1903, Mt. Komagadake in Prov. Kai (K. Tamura).

It is quite different from *P. Tranzschelii* Diet on *Cacalia hastata* and also from any Puccinia on *Senecio*.

Puccinia Benkei Kusano. n. sp.

Teleutosori mostly hypophyllous, arranged centrifugally, forming large roundish spots 6–8 mm. in diameter, prominent, round, compact, black, rarely epiphyllous in the central portion of spots; spores elliptical or oblong, equally rounded at both ends, very slightly constricted at the septum, wall somewhat thickened at the apex, smooth, light brown, 30–40 × 18–22 μ; pedicel persistent, long, thick-walled, slender, hyaline or pale, 140 μ.

On the leaves of *Sedum Telephium* L. var. *purpureum* Mats. Sept. 2. 1904, Nikko (S. Kusano).

It is easily distinguished from *P. Sedi* Koern on *Sedum* by its teleutospores. It approaches to *P. exanthematica* Mac Owan on *Crassula* in its whole aspect, but differs from the latter by having much larger spores with longer pedicels.

Spores germinate as soon as they mature, so that the fungus belongs to *Leptopuccinia*.

Puccinia Diplachnis Arthur.
(Torrey Bot. Club. 1904. p. 4)

Uredosori amphigenous, isolate, rarely confluent, small, oblong or linear, naked, pulverulent, orange coloured; spores obovate or elliptical, epispore hyaline, finely verrucose, contents orange coloured, 16–23 × 12–17 μ.

Teleutosori mostly hypophyllous, isolate, scattered, rarely confluent, compact, prominent, round, oblong or linear, black; spores fusiform or elliptical, mostly rounded or obtusely pointed at the upper end, somewhat tapering towards the lower end, slightly or not constricted at the septum, wall rather thin, slightly thickened at the apex, smooth, brown, 30–48 × 16–18 μ; pedicel persistent, hyaline, slender, 100 μ.

On the leaves of *Diplachne serotina* Link. var. *chinensis* Mak. Nov. 8. 1904, Komaba, (S. Kusano).

Phacopsora Meliosmæ Kusano. n. sp.

Uredosori hypophyllous, small, punctate, scattered, with no pseudoperidia, paraphyses numerous, clavate or swollen at the end to 25–38 μ in diameter, thick-walled at the apex; spores elliptical or obovate, coarsely echinulate, 20–25 × 15–18 μ.

Teleutosori hypophyllous, small, dense, sometimes confluent, covered by the epidermis, waxy, light brown; spores united together compactly, compressed, in 3–4 layers, mostly cubical or somewhat elongated, with polygonal outline in surface view, wall thin, light blown, 13–25 × 9–18 μ.

On the leaves of *Meliosma myriantha* S. et Z. Oct. 8. 1899, Mt. Takao in Prov. Musashi (S. Kusano).

Phragmidium Rubi Thunbergii Kusano. n. sp.

Sori forming mostly reddish to yellowish spots.

Uredosori hypophyllous, isolate, scattered or in groups, small, pulverulent, orange-yellow, with clavate, thin-walled, crooked paraphyses; spores obovate or elliptical, with thin, hyaline, finely echinulated epispore and orange coloured contents, 22–30 × 15–20 μ.

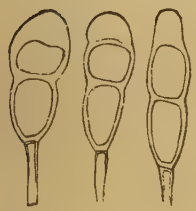
Teleutosori hypophyllous, scattered or in irregular groups, often in uredosori, small, roundish, yellowish brown to brownish black; spores 3–5 (mostly 4) celled, rounded at both ends, slightly pointed at the upper end,

slightly constricted at the septa, wall thin, smooth, not or slightly thickened at the apex, olive brown, epispore thick, pale glayish, contents orange coloured, 49–85 × 22–30 μ; pedicels thick-walled, not smooth, with orange-yellowish contents, 10 × 70 μ.

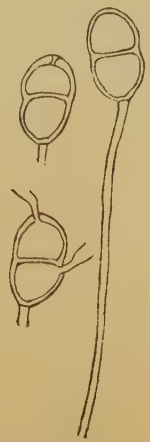
On the leaves of *Rubus Thunbergii* S. et Z. Oct. 30. 1904, Komaba (M. Shirai).

There are 2 germ-pores in each cell, placed laterally in the apical cell and under the septa in others. This fungus is allied to *Ph. griseum* Diet., but it differs from the latter by having 2 germ-pores and broader spores with shorter pedicels.

Spores germinate immediately after ripening. The promycelium and globular sporidia contain orange coloured granules.



Puccinia Cacaliæ Kus. × 400.

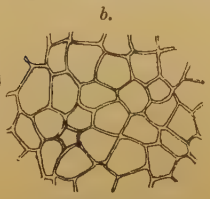


Puccinia Benkei Kus. × 400.

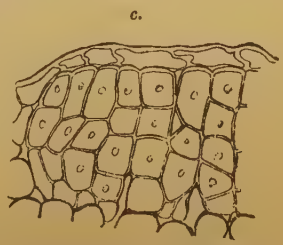
Puccinia Diplachnis Arth. × 400.

Phacopsora Meliosmæ Kus. × 400.

a, paraphyses



b, surface view of a teleutosorus.



c, cross section of the same.

Notes on the Japanese Fungi.

III. UROMYCES ON CLADRASTIS.

BY

S. Kusano.

Reprinted from Botanical Magazine, Tokyo, Vol. XIX, No. 223.

1905.

Notes on the Japanese Fungi.

III. UROMYCES ON CLADRASTIS.

BY

S. Kusano.

Uromyces shikokianus Kusano n. sp.

Teleutosori hypophyllous, isolate, indefinitely scattered, small, punctiform, pulverulent, black, paraphyses numerous, nearly solid, crooked, pale yellow; uredospores very few, intermixed with the teleutospores, obovate or broadly elliptical, wall rather thin, verrucose, yellowish brown, $25 \times 20 \mu$; teleutospores oblong or fusiform, but mostly pyriform, with pointed apex, wall dotted with large knobs, grayish brown to chestnut brown, thickened conically at the apex, $30\text{–}40 \times 16\text{–}18 \mu$; pedicel thin-walled, fragile, hyaline, nearly as long as the spore or somewhat longer.

On the leaves of *Cladrastis shikokiana* Makino. Oct. 1904, Mt. Yanaze in Prov. Tosa (T. Yoshinaga).

The material examined was somewhat incomplete, so that it is unknown whether uredospores form a distinct sorus or are found in the same sorus as teleutospores.

Uromyces Cladrastidis Kusano n. sp.

Teleutosori hypophyllous, isolate, indefinitely scattered, punctiform, pulverulent, black, paraphyses numerous, nearly solid, crooked, pale yellow; spores globose, oval or rarely elliptical, rounded at the lower end, obtusely or acutely pointed at the apex, wall finely verrucose, chestnut brown, slightly thickened at the apex, $20\text{–}27 \times 17\text{–}20 \mu$; pedicel thin-walled, fragile, hyaline, 50μ.

On the leaves of *Cladrastis shikokiana* Makino. Oct. 27. 1900, Chichibu in Prov. Musashi (Y. Yabe).

This species is closely allied to *U. shikokianus*, but differs in the form of teleutospores and the sculpture of their surface.

Uromyces amurensis Kom.

(Hedw. 1899. p. (54)).

Syn. U. oedipus Diet. (Eng. Bot. Jahrb. Bd. XXXIV. 1905. p. 583).

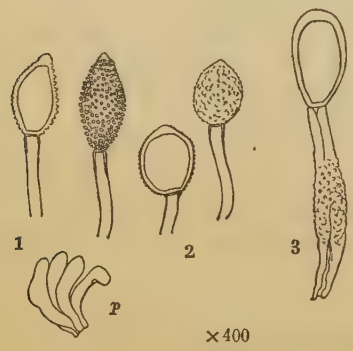
This fungus was first discovered by Komarov on *Cladrastis amurensis* Benth. in eastern Siberia (1895–1896) and is known also in Japan on the same host from the following localities :—

Teleutostage—Sapporo in Hokkaidō. Oct. 1889 (K. Miyabe).

Uredo and teleutostage—Mt. Fuji. Aug. 1901 (K. Tamura).

Aecidium, uredo and teleutostage—Tosa. June 1903 (T. Yoshinaga).

It is of special interest to note that the uredo and teleutosori are provided with hyaline membrane surrounding the spores. Unlike paraphyses or pseudoperidia, it consists of the mycelia fused together and envelops the spores until they would come to maturity.



1. Uromyces shikokianus. p, paraphyses.
2. U. Cladrastidis.
3. U. amurensis.

KEY TO THE SPECIES OF UROMYCES ON SOPHORA AND CLADRASTIS.

The following key is intended to avoid the confusion arising during the determination of Uromyces parasitic on *Sophora* as well as *Cladrastis*, which are sterile.[1)]

1) S. Kusano, Notes on the Japanese Fungi. I. Uredineæ on Sophora. Bot. Mag., XVIII. 1904. p. 1.

A. Teleutospore on stems ..... *U. truncicola* P. Henn. et Shir.
B. Teleutospore on leaves.
1. Sori with paraphyses.
a. Spore with knobs on its surface... *U. shikokianus* Kus.
b. Spore finely verrucose, less than 30 μ in length ..... *U. Cladrastidis* Kus.
2. Sori without paraphyses.
a. Spore with verrucose, swollen pedicel ..... *U. amurensis* Kom.
b. Spore with thin-walled pedicel.
Spore less than 30 μ in length, coarsely but clearly verrucose ..... *U. Sophoræ flavescentis* Kus.
Spore larger than 30 μ, finely verrucose ..... *U. Sophoræ japonicæ* Diet.

Notes on the Japanese Fungi.

IV. CÆOMA ON PRUNUS.

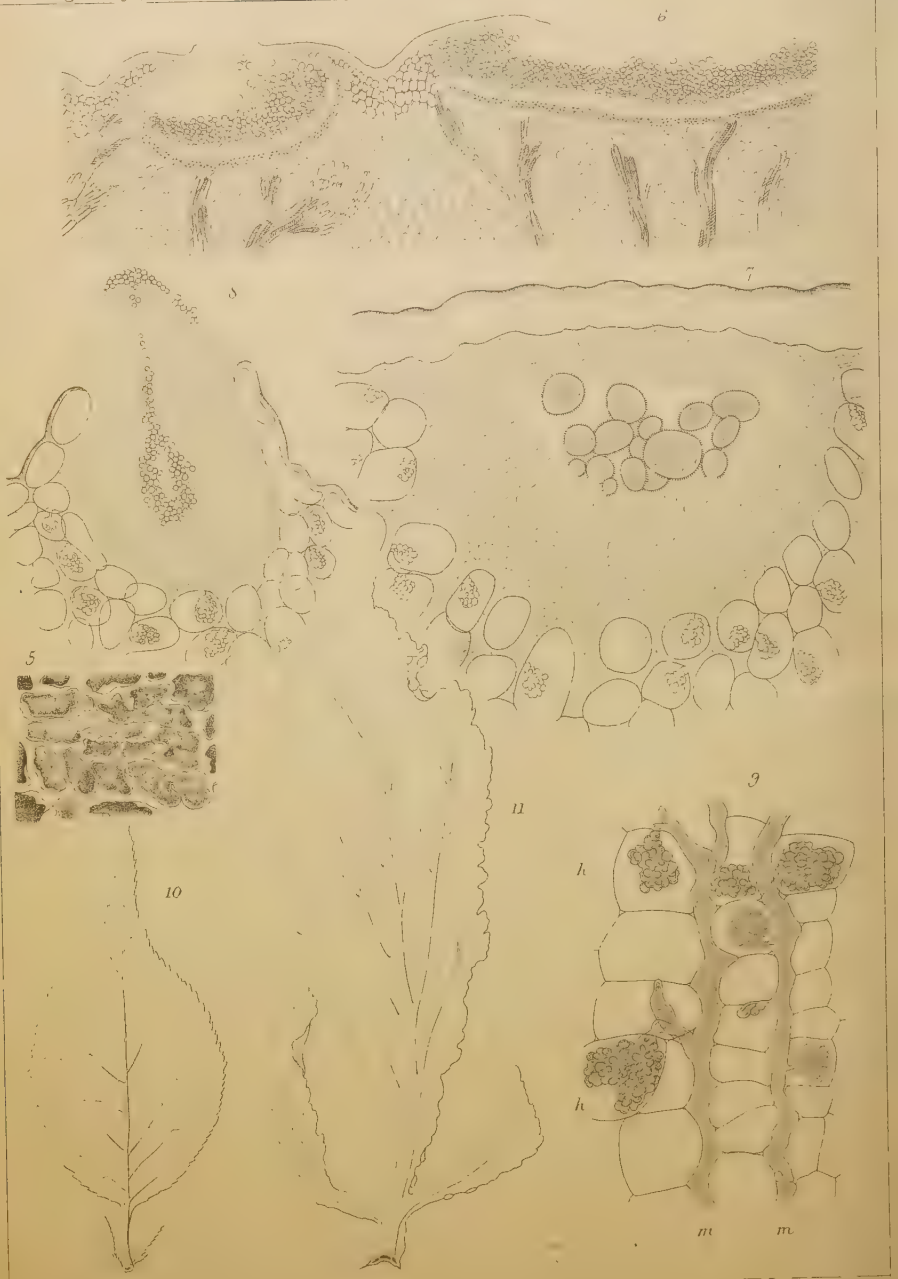
BY

S. Kusano.

With 2 Plates.

Reprinted from the Botanical Magazine, Tokyo, Vol. XX. No. 231.

1906.



S. Kusano del.

Caeoma Makinoi, Kusano.

S. Kusano phot.

Cæoma Makinoi, Kusano.

Notes on the Japanese Fungi.

IV. CÆOMA ON PRUNUS.

BY

S. Kusano.

With Plates III and IV.

Cæoma Makinoi Kusano n. sp.[1]

Sori epiphyllous, densely scattered, generally roundish on the marginal and oblong on the median portion of the host, sometimes confluent, size large, variable, sometimes attaining to 6×14 mm; spores oval or elliptical, epispore hyaline, finely verrucose, contents orange-yellow, size variable, 15–25×20–$42\ \mu$, generally $23 \times 31\ \mu$; hymenium dense with orange-yellowish contents.

Spermogonia amphigenous, crowded on the whole surface, but especially denser on the upper surface of the host. It forms finely granular elevation of orange-yellowish colour with filiform or club-shaped tuft of hyphæ at the aperture. Spermatia roundish, hyaline.

Hab.:—On *Prunus Mume* S. et Z. The fungus attacks the bud, and causes hypertrophy and distortion to the young shoot derived from it (Fig. 1). When the flower-bud is affected the ordinary course of development is perverted or changed, and it is subjected to a remarkable chloranthy or allied malformation (Figs. 2–4).

Loc.:—Yemura in Prov. Bitchu (Z. Sho, June 1901), Kobotoke in Prov. Musashi (T. Makino, May 1902), Nagafusa near Mt. Takao in Prov. Musashi (S. Kusano, June 1902, May 1903), Botanic Garden at Komaba (S. Kusano, May 1905), Nikko (S. Kusano, June 1904).

The affected buds seem to open somewhat earlier than the normal. As soon as shoots or flowers are derived from them the fungus begins to form spermogonia which are wholly replaced afterwards by the sori of aecidiospores (Figs. 3, 4), except on bracts, sepals and stipules of lower leaves

(1) S. Kusano, On a Fungus Disease of Prunus Mume. Bot. Mag., Tokyo. XVII. 1903. [Japanese].

of the shoot and also on the under surface of all other affected portions. The sori are so densely formed and æcidiospores are so massively developing that the affected portions become thickly covered by the brilliant orange-yellowish dust of spores concealing the light greenish surface of the host on which they occur (Fig. 5).

After the maturation of spores the diseased portions gradually die together with the fungus mycelium traversing them. However, we find occasionally that the mycelium may remain spreading up and down on the node of branch, on which the affected buds have developed. It effects slight swelling of the branch and winters intercellulary in the cortical parenchyma. The wintering mycelium can infect in the next spring young buds that may occur within its extent.

The hyphæ is double contoured, septate and branched, and has a diameter of 8.5–10 μ. It sends out, at short intervals, cystolith-like haustoria to the surrounding parenchymatous cells (Fig. 9).

Diseased leaves are exceedingly thick and succulent. Stipules deciduous in the normal state become persistent and assume the form and texture of the diseased blade (Figs. 10, 11).

In the chloranthic flowers the stalks greatly elongate and thicken to 15–20 mm in length and 5–6 mm in diameter. Sepals, on which no æcidiospore is formed, remain less deviated in form. However, the other floral organs, namely, petals, stamens and pistils are thrown into phyllomorphic change of various degrees.

It is only on those flower-buds, which are traversed in the earlier stage of development by the fungus mycelium through all portions, that the complete chloranthy takes place. In partially affected flowers, as shown in Fig. 2 *a*, each organ comes sooner or later to wither like that of normal flowers.

The following is the results of the teratological studies on the chloranthy:—

1. In the chloranthic flower the arrangement of all organs remain entirely undisturbed.

2. The phyllomorphic organs resemble in their general features the affected leaves instead of the normal.

3. The number of stamens undergoing the phyllomorphic change is very variable, some of them becoming often abortive.

4. The form of phyllomorphic stamens varies within wide limits; they become sometimes bilaminar leaves (Fig. 4 *g*), sometimes only the basal or upper portion of them become laminar, or dichotomous leaves are rarely produced (Fig. 4 *h*).

5. In the axil of stamens or in place of pistils prolification may take place.

6. The anther is sometimes represented as four wing-like processes (Fig. 4 *f*).

7. In place of the ovule a large lobe is found in some phyllomorphic pistils. The lobe seems to correspond to the integuments of the ovule while its nucellus is represented as a papilla on the center of the lobe. In a completely phyllomorphic pistil the lobe becomes less distinguishable from the serratures up and down of it (Fig. 4 *j-l*).

In transforming floral organs into leaves the fungus must act upon them before their embryonal development has ended.[1] As they are already differentiated at the beginning of winter (December), we are inclined to believe that the infection of the fungus would take place in autumn or earlier. It is quite obvious that such an earlier infection may be effected by the perennial mycelium, but it is difficult to explain how the spore-infection, the necessary means for the propagation of the fungus from tree to tree, may take place in such period. Cæoma being an æcidial form of certain Uredineæ, the formation of teleutospores is very provable. To determine whether sporidia derived from teleutospores or æcidiospores themselves[2] may infect *Prunus Mume* is of great interest and importance.

Cæoma Makinoi resembles in its habits *Cæoma radiatum* Shir on *Prunus Pseudo-Cerasus* Lindl. According to Shirai the sori and spermogonia of the latter species make their appearance at different places of the affected organ, sori occuring on the upper surface of the leaves, while spermogonia are found on the stipules or bracts. It has much larger spores but far smaller sori than *Cæoma Makinoi*. The other noteworthy difference between two species is the respective influence which they play upon their host. While in *Cæoma radiatum* it is reported that the perennial mycelium causes on the branch the phenomenon known as "witch's broom," no such action has ever been observed in the case of *Cæoma Makinoi*.

Through the kindness of Dr. G. Yamada, professor of the Higher Agricultural and Dendrological School at Morioka, I obtained specimens of

(1) Peyritch, Zur Aetiologie der Chloranthien einiger Arabis-Arten. Jahrb. f. wiss. Bot. XIII. 1882. P. 1.

(2) W. Brandi, Hedw. XLII. 1903. P. 118; Barclay, Trans. Linn. Soc. 1891, P. 141–151; Dietel, Zeitschrift. f. Pflanzenkrkb. III. 1893. P. 258; —, Flora 81. 1895. P. 394.

Cæoma on *Prunus Pseudo-Cerasus* Lindl. (Kuroishino near Morioka, May 25, 1904) and *P. Grayana* Max. (Kuroishino near Morioka, May 25, 1904). The fungus on the former plant was still immature, but its manner of development as well as its influence upon the host are quite the same as Shirai's type specimen of *C. radiatum*. The fungus on the latter plant attacks the young shoot and forms large sori all over the upper surface of the affected leaves. In respect to the dimension of the spore as well as to the form and manner of development of the sorus the fungus seems to be identical with *C. Makinoi*. However, the influence which it exerts upon the host is less energetic: hypertrophy of leaves is not so remarkable as on *P. Mume*, stipules are scarcely deformed, and the growth of the stem affected seems also to be less influenced. It is still unknown whether the present fungus causes witch's broom like *C. radiatum* or chloranthy like *C. Makinoi*. As a whole we find that the fungi on three different kinds of *Prunus* are morphologically closely allied. The answer to the question whether they are three distinct species or rather belong to a single species attacking different hosts, would depend upon the results of comparative studies of their life history.

Botanical Laboratory, Imperial University, Tokyo.

EXPLANATION OF FIGURES IN PLATES III AND IV.

Plate III.

Fig. 1. Diseased and normal shoot of *Prunus Mume*. The diseased leaves being covered densely by the sori of the fungus are rolled back. × $\frac{1}{2}$.

Fig. 2. Diseased flowers. *a*, partially affected flower with elongated and enlarged ovary, and with less deformed stamens, petals and sepals. *b*, *c*, incompletely chloranthic flowers. Some anthers remain unchanged. *d*, completely chloranthic flower still inclosing. The surface is covered with spermogonia. × $\frac{3}{4}$.

Fig. 3. Chloranthic flower at full growth with numerous sori of the fungus. × $\frac{3}{4}$.

Fig. 4. Phyllomorphic floral organs. *a–d*, petals. *e*, petal and abortive stamens. *f–i*, stamens. *j–l*, pistils. × $\frac{3}{4}$.

Plate IV.

Fig. 5. Large sori of the fungus on a carpellary leaf. Nat. size.
Fig. 6. Cross section of the sori on a diseased leaf. Under the sori numerous accessory veins are produced. Slightly magnified.
Fig. 7. Cross section of a sorus through its peripheral portion. × 250.
Fig. 8. Spermogonium. × 250.
Fig. 9. Cross section of the cortex of an infected branch of the host. *m*, perennial mycelium. *h*, haustorium. × 350.
Fig. 10. Normal leaf. Nat. size.
Fig. 11. Diseased leaf with enlarged stipules. Nat. size.

Notes on Japanese Fungi.

V. *Puccinia* on the Leaves of Bambuseae.[1]

BY

S. Kusano.

With Plate VI and one Figure in the Text.

Five species of *Puccinia* have been known to occur upon the leaves of bamboo-plants, of which two, viz. *P. longicornis* Pat. et Hariot and *P. Kusanoi* Diet., are indigenous to Japan, while the rest are exotic.[2] My attention has been directed to this subject for some years and an exhaustive examination of all the species of bamboo to which I have been able to get access has enabled me to add two more species and one variety still undescribed. To a description of these indigenous rusts I propose to append a complete list of their hosts, which now amounts to eighteen in number, belonging to three genera (*Phyllostachys*, *Arundinaria*, and *Sasa*), and thus place the relation of the rust to the several species of its host in a clear light. As is well known, the vegetative organs of the different species of bamboo exhibit hardly any distinctive features characteristic of each, while the floral organs, the most important for the study of affinity and specific characters, are developed exceedingly rarely. On this account, although the study of our bamboo-plants made recently by Makino and Shibata[3] from the systematic and anatomical standpoints

[1] Contribution from the Botanical Laboratory.

[2] *Puccinia Arundinariae* Schw. in America (Syn. Fung. Car., 1822. p. 72; Sacc., Syll. Fung., Bd. XIV. p. 355; Bot. Gaz., Vol. XXXIV, 1902, p. 1; Syd., Monogr. Ured. I, p. 731). *P. xanthosperma* Syd. in East India (Ann. Myc., Bd. IV, 1906, p. 437), and *P. melanocephala* Syd. in East India (Ann. Myc., Bd. V, 1907, p. 500).

[3] Makino, T., Description des Produits forestiers envoyés à l'Exposition universelle de 1900 à Paris par le Ministère de l'Agriculture et du Commerce;—, Bambusaceae Japonicae. Bot. Mag., Tokyo, Vol. XIV, 1900; Shibata, K., Beiträge zur Wachstumgeschichte der Bambusgewächse. Journ. of Coll. Sci. Tokyo Imp. Univ. Vol. XIII, 1900; Makino, T. and Shibata, K., On Sasa, a new genus of Bambuseae, and its Affinities. Bot. Mag., Tokyo, Vol. XV. 1901, p. 18.

has rendered the systematic position of each species very definite, it seems to me that an account of the specialisation of the rust on certain species of bamboo is important from a practical point of view for the determination of the genera and species, in case only their branchlets or leaves are accessible.

In order to avoid any possible error regarding the specific name of the hosts, due to an examination of sterile specimens in a dried state, I have consulted as far as possible living specimens which had been identified by Mr. MAKINO, the authority on Japanese bamboo. They are all cultivated in the Botanic Gardens both of the Science College and the Agricultural College in Tokyo, with the single exception of *Sasa ramosa* which is found flourishing in Sōma in Prov. Iwaki.

I desire in this place to acknowledge my indebtedness to Prof. MIYABE who has generously put at my disposal the rich herbarium specimens of the Museum of the Agricultural College of Sapporo, which have been particularly useful for a study of the distribution of the fungi concerned.

Puccinia Phyllostachydis Kusano n. sp.

(Figs. 1, 2, 10, 11.)

Uredosori hypophyllous, isolated, early becoming naked, pulverulent, ferruginous; paraphyses hyaline, swollen and thick-walled at the top, with a septum near the top[1]; spores obovate, 30-33×23-25 μ; epispore brown, coarsely echinulate; pores 4 (rarely 5), equatorial.

Teleutosori hypophyllous, isolated, scattered, prominent, round, compact, 0.5 mm. in diameter, dark brown or black; spores oblong, rounded at the upper end, slightly tapering towards the lower end, constricted at the septum, wall scarcely or not thickened at the apex, finely dotted, brown, 45-70×15-20 μ; pedicel persistent, slender, hyaline, more than 150 μ long.

Common in various places in Tokyo.

[1] I can not yet exactly decide whether they are young sporophores or not.

On *Phyllostachys bambusoides* Sieb. et Zucc. (= *Ph. megastachya* Steud. ' *Ph. macrantha* Sieb. et Succ., *Ph. Quirioi* Riv., *Ph. Mazeli* Hort.) B.G.[1]; Komaba; Kyoto*[2] (Y. Takahashi, July 4, 1895; N. Hiratsuka, June 12, 1895).

Phyllostachys bambusoides Sieb. et Zucc. var. *aurea* Makino (=*Ph. aurea* Riv.). B.G.

Phyllostachys bambusoides Sieb. et Succ. var. *Marliacea* Makino (=*Ph. Marliacea* Mitf.). B.G.

Phyllostachys bambusoides Sieb. et Zucc. forma *Kasirodake* Makino. B.G.

In general feature the teleutospores appear to resemble those of *Puccinia Arundinariae* Schw. with thin-walled apex, judging from the figures of J. C. Arthur,[3] but the present species is distinguished by the presence of paraphyses in the uredosori.

It is a very interesting fact that this species is confined to the four forms above mentioned, which according to Makino must all be referred to *Ph. bambusoides*.[4] As may be seen from the synonyms, these had been regarded as so many different species, but the specialisation of *Puccinia Phyllostachydis* on these bamboos points to a more close relationship among themselves in contrast to the others, and so Makino's revision appears justified from the mycological point of view.

When the branchlets and leaves alone are taken into consideration, *Phyllostachys bambusoides* var. *aurea* resembles very closely *Ph. puberula* Munro, but the occurrence of the rust, if any, will enable one to distinguish the two.

[1] B. G.—Botanic Gardens, Koishikawa, Tokyo.

[2] *=Dried specimen.

[3] J. C. Arthur. The Uredineae occurring upon *Phragmites*, *Spartina*, and *Arundinaria* in America. Bot. Gaz., Vol. XXXIV, 1902, p. 1.

[4] The genus *Phyllostachys* includes 4 species and a number of varieties. Bot. Mag., Tokyo, Vol. XIV, 1900, p. (61).

Puccinia longicornis Pat. et Hariot.

(Figs. 3, 4.)

Bull. Soc. Myc. France, 1891, p. 143; Sacc., Syll. Fung., Bd. XI, p. 200; Syd., Monogr. Ured., I, p. 734; —, Exic. Ured., n. 1314.

This is a species of common occurrence. As far as my observations go, it is found every year in the Botanic Garden at Koishikawa and other localities in Tokyo. The formation of the teleutospores at a certain season of the year is so vigorous that they form solid, ferruginous to dark brownish, orbicular pustules of 1 mm. or sometimes more in diameter, and cover densely the under surface of the leaves, doing much damage to the host.

In general features the uredosori resemble those of the preceding species. They are however characterised by having clavate paraphyses (Fig. 4). The spores are globose or oval, and coarsely echinulate. Four or rarely five germ-pores are present in the equatorial plane.

The typical teleutospores are elongated, fusiform, well constricted at the septum, and tapering at both ends. Some deviating forms resemble those of the typical spores of *P. Kusanoi*, or its variety to be described below (Fig. 3*a*, *b*). The distinctive character of the spore is the extraordinary thickening of the wall of the apex so as to form a long papilla of 32 μ in length. The typical ones measure 80-100 × 15-20 μ. Pedicel is hyaline, slender, and more than 200 μ long.

Only two species of bamboo have so far been ascertained as host:—

Sasa paniculata Makino et Shibata (=*Bambusa tessellata* Munro,[1] *B. palmata* Marl., *B. paniculata* Makino, *B. senansis* Franch. et Sav., *Arundinaria palmata* Bean, *A. kurilensis* var. *paniculata* Fr. Schw., etc). B.G.; Sapporo* (T. Miyake, May 4, 1902).

Arundinaria japonica S. et Z. B.G.; Nagoya in Prov. Owari* (Y. Takahashi, July, 1895).

[1] Dietel, Uredineae Japonicae. I. Engl. bot. Jahrb., Bd. XXVIII, 1899, p. 568.

The fact that the present rust is confined to the two hosts mentioned above seems to show the close relationship of the latter, though they are now included in different genera. The bamboos now included in *Sasa* were formerly considered to belong to *Bambusa* in the section Eubambuseae, but their anatomical as well as morphological characters necessitated a revision, and thus a new genus *Sasa* was erected conjointly by Makino and Shibata.[1] To this genus are now referred eight species which were all formerly included in *Bambusa*. Taking the rust as our guide it appears that *Sasa* and *Arundinaria* are allied genera. The above authors have already remarked that *Arundinaria japonica* is a somewhat aberrant form in the genus, and stands rather close to *Sasa* in the character of the culm and leaves, and in having at times more than 3 stamens[2]: it is in fact a transitional form between the two genera. Hence it is not strange that *Arundinaria japonica* should harbour the rust apparently peculiar to *Sasa*, instead of the one which occurs commonly on several species of *Arundinaria*.

Puccinia Kusanoi Diet.

(Figs. 5, 13, 14.)

Engl. bot. Jahrb., Bd. XXVIII, 1899, p. 568; Sacc., Syll. Fung., Bd. XVI, p. 309; Syd., Monogr. Ured., I, p. 732; —, Exic. Ured. n. 1313, 1373.

(=*Uredo Arundinariae* Syd.). Hedwigia, 1898, p. (208); Sacc., Syll. Fung., Bd. XIV, p. 406; Syd., Exic. Ured. n. 1239.

(=*Puccinia Bambusae* Schroet. in herb.)

This rust is most common owing to the wider distribution of its host. It is found mostly on species of *Arundinaria*, thus:—

Arundinaria Simoni A. et C. Riv. B.G.; Tokyo* (S. Hori, March 19, 1891; K. Miyabe, Sept., 1889; K. Ōkuma, April 30, 1883; K. Sengoku, Nov. 25, 1895, Jan. 14, 1896; T. Nishida, Oct. 24, 1899);

[1] Makino, T. and Shibata, K., *loc. cit.*

[2] *Phyllostachys* and *Arundinaria* have 3 stamens, while in *Bambusa* and *Sasa* they are 6 in number.

Ōmiya near Tokyo* (N. Ichikawa, Oct., 1886); Chiba in Prov. Kazusa* (K. Sengoku, Jan. 1, 1896); Hakone* (S. Hori, April, 1891; K. Miyabe, April 12, 1901); Gifu* (N. Tokubuchi, Oct., 1889, Dec. 3, 1898).

A. Simoni A. et C. Riv. var. *Chino* Makino. B.G.; Komaba; Sendai* (K. Sengoku, Oct. 5, 1895).

A. Simoni A. et C. Riv. var. *variegata* Hook fil. B.G.

A. variabilis Makino var. *viridi-striata* Makino (=*A. Fortunei* Riv.[1]). B.G.

A. variabilis Makino var. *Tanakae* Makino. Komaba.

A. variabilis Makino forma *foliis pubescens* Makino. Hirosaki in Prov. Mutsu* (N. Hiratsuka, Oct. 26, 1896); Shiroishi in Prov. Iwaki* (Y. Takahashi, Aug. 1, 1895); Nagoya in Prov. Owari* (Y. Takahashi, July 19, 1895).

A. variabilis Makino forma *foliis glabris* Makino. Tokyo* (Y. Takahashi, July 21, 1895).

A. Narihira Makino. B.G.; Komaba.

A. Narihira Makino forma *Yashadake* Makino. Komaba.

Sasa sp. (*S. nipponica* Mak. et Shib.?). B.G.; Prov. Rikuchū* (Y. Takahashi, Nov. 7, 1897, May 13, 1893).

Thus, out of eight species of our native *Arundinaria*[2] the fungus occurs on three species and their varieties. Of these hosts, the first two are most widely distributed, from south to north, especially however in the central part of Japan, and are everywhere subject to attack by the rust.

The uredosori do not differ essentially in appearance from those of the other species, except that they lack paraphyses which characterise two species described before. The spores are obovate to subglobose, with coarsely echinulate wall. The size varies, more or less, according to the host. For instance, it is smaller on *Arundinaria Simoni*, measuring 20 – 25 to 21 – 30 μ, but on the other hosts it may attain

[1] Engl. bot. Jahrb., Bd. XXVIII, 1899, p. 569.

[2] Bot. Mag., Tokyo, Vol. XIV, 1900, p. (61).

to 27×28 or even 27×35 μ. There are apparently three or four germ-pores in the equatorial plane.

The teleutospores form solid, firm, orbicular sorus just as in the preceding species. The typical ones are oblong or fusiform, rounded at both ends, the wall conically thickened at the apex. They measure 61×17 μ or thereabout, but there may occur even in the same sorus very short and broad spores measuring from 42×22 to 40×20 μ. Moreover, slight variation in form and size may occur according to different hosts. For instance, on *A. Narihira* forma *Yashadake* large spores predominate which may measure as much as 88×16 or 70×15 μ. Sometimes they are linear oblong, not constricted at the septum and tapering gradually at both ends. On *A. Simoni* and its varieties *Chino* and *variegata* the constriction at the septum is somewhat conspicuous; on *A. Narihira* the apex of the spore is rounded, the constriction is more obvious, and the shorter ones are more predominant; and on *A. variabilis* var. *viridi-striata* and *A. Narihira* forma *Yashadake* larger ones with a slight constriction at the septum are more usual.

With respect to the occurrence of the rust upon a species of *Sasa* a question arises again concerning the affinity of *Arundinaria* and *Sasa*, and also concerning the specific name of *Sasa* in question. The plant has been cultivated for a long time in the Botanic Garden of Tokyo but has never produced floral organs. Mr. MAKINO inclines to the view that it is *Sasa ramosa* Makino et Shibata, though the sterile specimens do not show distinctly any character to distinguish it from *Sasa nipponica* Makino et Shibata. As the rust on the *Sasa* in question is somewhat different from that on the typical *Sasa ramosa*, which will be given below, I believe it better to assume at present the questionable *Sasa* as *S. nipponica*.

The rust on *S. nipponica* bears a more close resemblance to that on *Arundinaria Narihira* forma *Yashadake* (Fig. 5 *c-f*). The uredo and teleutosori are smaller than on other hosts; the oval uredospores measure from 40×20 to 42×25 μ; the teleutospores are long and regular in form, well constricted at the septum; and the typical ones measure

from 72 × 19 to 65 × 20 μ, but deviating ones may be 80 × 17 — 55 × 20 μ. The general characters of the rust on *S. nipponica* are therefore quite the same as those of the rust on most *Arundinaria*.

This singular fact indicates that some species of *Sasa* may be closely allied to the genus *Arundinaria*. As has been ascertained from anatomical as well as floral characters[1] certain species of *Sasa* resemble *Arundinaria Simoni*, just in like manner as *A. japonica* approaches to *Sasa*. In the present case it seems probable that *S. nipponica* stands next to *S. ramosa* which in turn is closely related to *A. Simoni*: *S. nipponica* is phylogenitically nearer to *A. Simoni* than to *A. japonica*[2].

Puccinia Kusanoi Diet. var. **azuma** Kusano n. var.

(Figs. 6, 12, 15.)

Uredosori hypophyllous, isolated, small, naked, pulverulent, ferruginous, without paraphyses; spores oval to obovate, 25-28×20-25 μ, epispore brown, coarsely echinulate, germ-pores 4-3, equatorial.

Teleutosori hypophyllous, isolated, scattered, prominent, round, compact, 0.5-1.0 mm. in diameter, black to brown; spores linear oblong, tapering towards both ends, not or rarely constricted at the septum, wall conically thickened at the apex, brown, finely verrucose, 55-87 × 12-20 μ; pedicel persistent, slender, hyaline, more than 200 μ long.

It has been found at Koganei near Tokyo (T. MAKINO, May, 1894)*, and Sōma in Prov. Iwaki.

On *Sasa ramosa* Makino et Shibata (= *Bambusa ramosa* Makino, *Arundinaria ramosa* Makino).

In the general form of the teleutospores the present species resembles *Puccinia longicornis*, but differs from it in having the wall at the apex less thickened. Generally the constriction at the septum is exceedingly slight, and the spores are longer than those of *P. Kusanoi*. At times we find some short and broad spores which resemble the typical

[1] MAKINO and SHIBATA, *loc. cit.*

[2] See MAKINO and SHIBATA, *loc. cit.*, p. 30.

spores of *P. Kusanoi*, but since the above mentioned characters of the spores as well as others remain constant on *S. ramosa*, I think it better to distinguish the rust as a new variety. This will seems natural when we take into consideration the relationship of the host to *Arundinaria*. The authors of the genus *Sasa* remark, "*Sasa ramosa*, which we include provisionally in our new genus, resembles, however, *Arundinaria Simoni* in its floral characters, and has often less stamens than 6. Further study will decide whether it represents the type of a distinct genus or not"[1] Thus, the host seems to be different from other *Sasa*, intermediate between *Arundinaria* and *Sasa*, and for this reason it is not strange that its parasite is closely related to *P. Kusanoi*. Infection-experiments will perhaps decide whether the rust on *S. ramosa* is or is not specifically identical with that on *Arundinaria Simoni*.

Puccinia Sasae Kusano n. sp.

(Figs. 7-9.)

Uredosori hypophyllous, isolated pulverulent, ferruginous; paraphyses hyaline, swollen at the top; spores globose or subglobose, 32-35 μ; epispore very thick, brown, coarsely echinulate; germ-spores 5, equatorial.

Teleutosori hypophyllous, isolated, prominent, round, compact; spores oblong, rounded at the upper end, tapering towards the lower, constricted at the septum, lower cell generally longer, wall not or slightly thickened at the apex, finely verrucose, brown, 37-80 × 14-20 μ.

On *Sasa borealis* Makino et Shibata. Nikko* (T. Makino, Aug., 1905).

In a single dried specimen the rust was imperfectly preserved and almost all the teleutospores had germinated. In general appearance the teleutospores resemble those of *Puccinia Phyllostachydis*, but the upper cell is mostly wider and shorter than the lower. Among a large number of longer, thin-walled, light brownish teleutospores we find a few shorter

[1] Makino and Shibata, *loc. cit.*, p. 39.

and broader, thick-walled, dark brownish ones. The paraphyses resemble those of *P. longicornis*. The uredospores are the largest and have the thickest wall of the rusts described above, and they are also characterised by having 5 germ-pores. Although the specimen is somewhat imperfect, still these characters show beyond doubt that it can not be referred to any of the other species that are found on the bamboo-leaves.

General Characters and Development of the Fungi.

All the known species of *Puccinia* on the leaves of our bamboo-plants present externally nearly the same characters and can scarcely be distinguished from each other. The only differences which can be regarded as of diagnostic value are the structure of the uredosori and

Text-Fig. 1.
Young shoot of *Sasa paniculata*. *a*, at the time the teleutospores germinate; *b*, at the end of May.

the form of the teleutospores. In *Puccinia Phyllostachydis*, *P. longicornis*, and *P. Sasae* characteristic paraphyses occur which are wanting

in *P. Kusanoi* and its variety; and the thickening at the apex of the teleutospore is exceedingly slight in *P. Phyllostachidis* and *P. Sasae*, prominent in *P. Kusanoi* and its variety, and most remarkable in *P. longicornis*.

The most vigorous formation of the teleutospores takes place, so far as observed in Tokyo, in February and March, and they come to germinate at the beginning of April, whenever moisture is supplied in sufficient quantity. The uredosori appear all at once on the same leaves on which the teleutospores are developed, or on the young leaves of new shoots, attaining their full development at the end of May. The portions of the young leaves on which the uredosori first appear, are strictly those that were exposed exactly at the time the teleutospores were germinating (Text-fig. 1). It is therefore highly probable that the uredosori originate from the sporidia. The rust then proceeds to attack the young leaves as they come out one after another, developing successively new uredosori upon them. The development, however, is exceedingly retarded in the summer and autumn, and so the leaves developed later are for the most part apparently healthy, though a few discoloured spots may be observed, which are points infected by the uredospores. As winter approaches we recognize here and there a few teleutosori appearing from these diseased spots, but the number of the sori is not so numerous in midwinter as in the early spring. This is an ecologically interesting fact. Usually the teleutospores are the hibernating spores in many Uredineae, and they are formed at the beginning of winter, or sometimes when the host has completed its vegetation period, which occurs in some species in the summer. In bamboo-plants, the leaves are all perennial, and survive mostly till the end of the second year. Hence, if the cold season is concerned in the formation of the teleutospores in the bamboo-rust, it seems that the teleutospores must all be formed in or before the winter, instead of in the next spring. The fact being, however, otherwise, we must ascribe this unusual mode of development to another unknown cause, for which a further study is required.

The unfavourable conditions of the autumn and winter check the

development of the fungus, and it is practically in a resting state during these seasons. The numerous fine discoloured spots which we find during the winter on the leaves are produced by the uredospores disseminated during summer, and the intercellular mycelium developed in these spots is mostly inhibited from further development till the spring of the next year: the fungus can therefore winter in the form of sterile mycelium in the tissue of the host, as many perennial fungi do. The formation of the teleutospores in the spring appears to be a means of propagation for the fungus upon the young leaves by the formation of sporidia. As the function of the teleutospores is thus somewhat different from that of many other rusts, it does not seem strange that the wintering mycelium in the infected spots does not always develop teleutospores, but uredospores as is often observed especially during warmer winter[1].

The mode of germination of the teleutospores is quite similar in all the species. Kept in a moist chamber they germinate in from 24 hours to a few days, the first noticeable change being the production from the upper cell of a short curved promycelium consisting of four cells each bearing a pyriform sporidium. In water they send out a long germ-tube which may sometimes grow to 700 μ, usually with no septum (Fig. 11), or produce unusually long and thick sterigmata (175 μ) with or without sporidia (Figs. 12, 13).

The formation of abnormal promycelium is common in the rust on *Sasa nipponica*, and appears to take place under the same conditions as in other species. While the sterigma is usually produced near the upper septum, the second sterigma appears in this species constantly at the lower septum (Fig. 13). This is the character by which we can distinguish the rust on *Sasa nipponica* from *Puccinia Kusanoi* on *Arundinaria*, but it is of too little value to be taken as a specific character of the rust on this problematic *Sasa*.

March, 1908.

[1] It was most remarkable in the spring of 1907 on *Arundinaria Simoni*, *A. Varihira* f. *Yashadake*, and *Phyllostachys bambusoides*.

Key to the Species.

I. The wall at the apex of the teleutospore thickened very slightly.
   a. Uredosori with septate paraphyses ..... *P. Phyllostachydis* Kusano.
   b. Uredosori with non-septate paraphyses ..... *P. Sasae* Kusano.

II. The wall at the apex of the teleutospore thickened conically.
   a. Teleutospore broad and constricted at the septum ... *P. Kusanoi* Diet.
   b. Teleutospore long and not constricted at the septum .....
   P. Kusanoi Diet. var. *azuma* Kusano.

III. The wall at the apex of the teleutospore produced into a long papilla; uredosori with paraphyses ..... *P. longicornis* Pat. et Hariot.

Host-Index.

Arundinaria japonica Sieb. et Zucc...	*Puccinia longicornis* Pat. et Hariot.
A. Narihira Makino	*P. Kusanoi* Diet.
A. Narihira Makino, forma *Yashadake* Makino	*P. Kusanoi* Diet.
A. Simoni A. et C. Riv.	*P. Kusanoi* Diet.
A. Simoni A. et C. Riv. var. *Chino* Makino	*P. Kusanoi* Diet.
A. variabilis Makino var. *Tanakae* Makino	*P. Kusanoi* Diet.
A. Simoni A. et C. Riv. var. *variegata* Hook fil	*P. Kusanoi* Diet.
A. variabilis Makino var. *viridi-striata* Makino ...	*P. Kusanoi* Diet.
A. variabilis Makino forma *foliis glabris* Makino	*P. Kusanoi* Diet.
A. variabilis Makino forma *foliis pubescens* Makino ...	*P. Kusanoi* Diet.
Phyllostachys bambusoides Sieb. et Zucc	*P. Phyllostachydis* Kusano.
Ph. bambusoides Sieb. et Zucc. var. *aurea* Makino ...	*P. Phyllostachydis* Kusano.
Ph. bambusoides Sieb. et Zucc. var. *Marliacea* Makino...	*P. Phyllostachydis* Kusano.
Ph. bambusoides Sieb. et Zucc. forma *Kashirodake* Makino.	*P. Phyllostachydis* Kusano.
Sasa borealis Makino et Shibata	*P. Sasae* Kusano.
S. nipponica Makino et Shibata (?)	*P. Kusanoi* Diet.
S. paniculata Makino et Shibata	*P. longicornis* Pat. et Hariot.
S. ramosa Makino et Shibata	*P. Kusanoi* Diet. var. *azuma* Kusano.

Explanation of Figures.

All figures except Figs 7—9 are drawn from fresh specimens and magnified 400 times.

Fig. 1. Teleutospores of *Puccinia Phllostachydis*. *a*, longer spore; *b-e*, typical spores.

Fig. 2. Paraphyses in the uredosori of *Puccinia Phyllostachydis*.

Fig. 3. Teleutospores of *Puccinia longicornis*. *a*, *b*, shorter spores; *c-f*, typical spores.

Fig. 4. Paraphyses in the uredosori of *Puccinia longicornis*.

Fig. 5. Teleutospores of *Puccinia Kusanoi*. *a*, *b*, on *Arundinaria Simoni* var. *Chino*; *c-f*, on *Sasa nipponica* (?).

Fig. 6. Teleutospores of *Puccinia Kusanoi* var. *azuma*. *a*, short and broad spore; *b-e*, typical spores.

Fig. 7. Teleutospores of *Puccinia Sasae*. *a-c*, typical spores; *d-e* round form.

Fig. 8. Uredospores of the same. *a*, ripe spore; *b*, young spore.

Fig. 9. Paraphyses in the uredosori of *Puccinia Sasae*.

Fig. 10. First stage of germination of *Puccinia Phyllostachydis* on *Phyllostachys bambusoides* var. *aurea* (after a week).

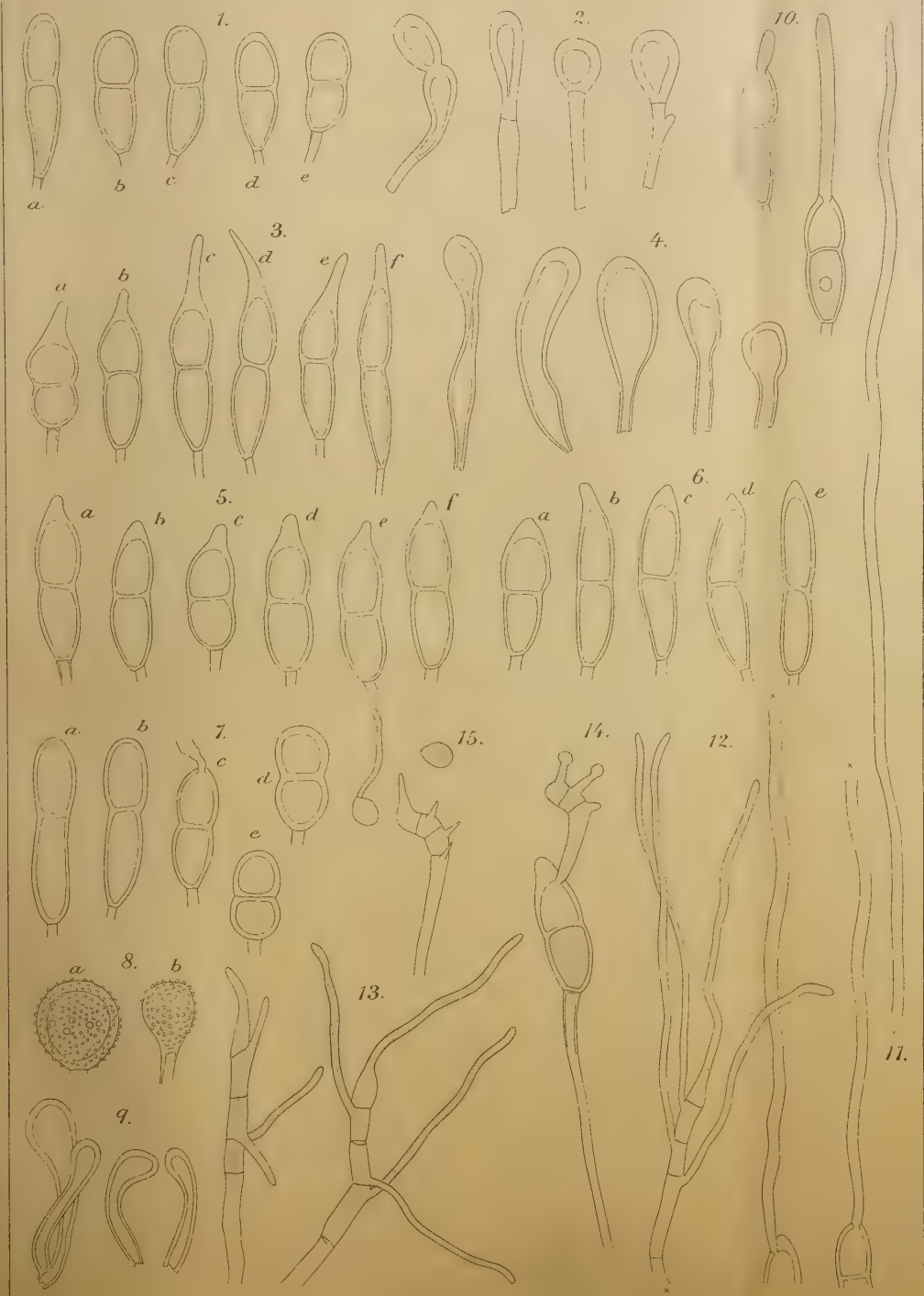
Fig. 11. Germination of the same in water (after a week).

Fig. 12. Germination of *Puccinia Kusanoi* var. *azuma* in water (after 24 hours).

Fig. 13. Germination of *Puccinia Kusanoi* on *Sasa nipponica* (?) in water (after 24 hours).

Fig. 14. Germination of the same in moist air.

Fig. 15. Basidium and sporidia of *Puccinia Kusanoi* var. *azuma*.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Biology of the Chrysanthemum-Rust.[1]

BY

S. Kusano.

With one Figure in the Text.

Black Rust (*Puccinia Chrysanthemi* Roz.).

Some years ago a most dreadful rust appeared suddenly in several countries of Europe and America, and furiously spread in a short interval of time, inflicting no inconsiderable damage upon chrysanthemum-cultivation.[2]

Although it was thought at that time that the rust was imported from Japan, where the same rust had long been known to attack the same plant, yet the correct specific name of the fungus has remained undetermined. Some held the view that it was identical with *Puccinia Hieracii* Mart[3] while others took it for *P. Tanaceti* Dc. or *P. Balsamitae* (Str.) Rbh. Roze after a more careful study has, however, arrived at the conclusion that it was different from any known species, and consequently called it *P. Chrysanthemi* n. sp.[4]

Subsequently Hennings described the Japanese species as new to science under the name of *P. Chrysanthemi chinensis*[5] which, however, P. Sydow has identified with the known species, *P. Pyrethri* Rab.[6] This

[1] Contribution from the Botanical Laboratory. A short account has already appeared in Japanese in Bot. Mag., Tokyo, Vol. XVIII, 1904, p. 99.

[2] See Jacky, E., Der Chrysanthemum-Rost. Zeitschr. f. Pflanzenkrankh., Bd. X, 1900, p. 132.

[3] Massee, G., Chrysanthemum-Rust. Gardener Chron., Vol. II, 1898, p. 269.

[4] Roze, E., Le Puccinia Chrysanthemi, cause de la Rouille du Chrysanthemum indicum L. Bull. de la Soc. myc. de la France, T. XVI, 1900, p. 88.

[5] Hennings, P., Einige neue Japanische Uredineen. Hedwigia, Bd. XL, 1901, p. (26).

[6] Sydow, P., Monographia Uredinarum, I, p. 45.

confusion in the identification of the chrysanthemum-rust seems to have arisen from the small morphological difference exhibited by the allied species of the genus. JACKY[1] then undertook a comparative study of Japanese and European rusts. His infection-experiments proved that the rust of *Chrysanthemum indicum* L. did not infect other *Chrysanthemum* or other allied plants of Compositae, except *Chrysanthemum sinense* Sab., the natural host of the rust in Japan, and that the Japanese rust of *Chrysanthemum sinense* could easily infect *Chrysanthemum indicum*, the host of the European rust. There being no morphological difference both in uredo and teleutopores taken from both hosts, he came to the conclusion that the Japanese rust was identical with the European, and hence he referred it to *Puccinia Chrysanthemi* Roz.

But curiously enough, there exists a great difference between the Japanese and European rusts in their mode of development. The European species repeats the uredogenerations through the year, and the uredospores can winter on the young shoots of the host kept in the house. The formation of the teleutospores is exceedingly rare. When they are formed, mesospores accompany them invariably. Further, we have in almost all cases variously formed and two-celled uredospores in the European species. As JACKY noted, the formation of mesospores and two-celled uredospores, abnormal as it may be, is almost constant[2]. In the Japanese species such cases seem to occur very seldom. In Tokyo and its vicinity the uredogeneration is regularly followed by the teleutostage, and the hibernating teleutospores germinate at once in the early spring. The following is the development of the rust observed by myself in Tokyo.

The first appearance of the uredosori takes place at the end of May or at the beginning of June, when the host has attained the height of 30cm. or thereabout. Among several garden-varieties of the host-plant placed side by side a certain variety was first attacked by the rust. At the Botanic Garden of the Agricultural College, Komaba, it was observed

[1] JACKY, *loc. cit.*; ——, Der Chrysanthemum-Rost. II. Centralbl. f. Bakteriol., II. Abt., Bd. X, 1903, p. 369.

[2] JACKY, *loc. cit.* Centralbl. f. Bak.

that a variety called "Ōmihakkei" first produced the uredosori on its lower leaves. The rapid spread of the rust later on to other varieties seemed to be due to infection from this source. At the beginning of July almost all the varieties were attacked by the rust.

A most careful examination has failed to reveal any spermogonium in the first generation of uredosori, so that it is most probable that the fungus belongs to Hemipuccinia.

In the autumn, when the host approaches its flowering season, the uredostage is followed by the teleutostage. I have found it at the beginning of October. Afterwards the teleutosori spread over most rapidly from the lower portions of the stem up to the bracts of the heads.

It may be noticed that in the first generation of the teleutostage the sori form a ring of 1.5-3.0 mm. in diameter around each uredosorus of the last generation, so that there is no doubt that the teleutosori may originate from the mycelium around the uredosorus. Numerous isolated teleutosori developed afterwards seemed to originate from the urdeospores of the year.

In early winter, when the stems begin to wither from injury by the frost, young shoots appear from the mother-stock. The fungus then invades these vigorous offsprings perhaps by means of the uredospores, and forming there the teleutosori it can winter on the living host. Though rare, a few new teleutosori made their appearance even in the midst of the winter (end of January), but later the formation of the sori seemed to have ceased entirely.

The teleutospores on the dead host of the last year germinated at once in April. The uredosori which, as stated above, suddenly appear at the end of May probably owe their origin to the sporidia thus produced from the teleutospores.

Such being the course of development of the rust in Tokyo, I will now give a few observations made in a warmer region in Japan. At my request Mr. Yoshinaga has made some observations since a few years on the development of the rust in Prov. Tosa, and he has kindly put

the specimens he has collected at different localities from time to time at my disposal. An examination of these specimens shows beyond doubt that the rust produces in these warm coastal localities, as for instance Akimachi and Kōchi[1], only uredosori generation after generation through the year without the formation of teleutospores even in the midst of the winter. It suggests to us the possibility of the uredospores retaining in these localities their germinating power through the winter and becoming a new starting point for the rust in the next year. This must be admitted to be perfectly possible, as the uredospores exposed to -25°C. may retain, according to JACKY[2], their germinating power.

As in this way the rust develops in the coastal region of Tosa just as in Europe without the formation of the teleutospores, I have given special attention to the abnormal formation of spores at the localities mentioned above. In the specimens collected at Kōchi[3], December 13, 1907[4], which consisted entirely of vigorously developed uredosori, I could without difficulty find numerous abnormal and two-celled uredospores, as in the European specimens. Further, the formation of mesospores was ascertained at somewhat colder localities in Tosa. Mr. YOSHINAGA has already found in November, 1901 abundant teleutospores at Sakawamachi[5], 4 *ri* (*ca.* 10 miles) distant from the sea-shore, and quite recently he has collected them again in a mountainous region Ujimura, 1.5 *ri* west from Kōchi on December 15, 1907[6]. In both specimens the teleutospores were developed as much as in those of Tokyo, but their form was much irregular, and the sori contained mesospores. These facts show clearly that the abnormal formation of spores is not a characteristic of the rust introduced to Europe, but takes place in its native country, though not constantly.

As regards the constant formation of abnormal spores in Europe

[1] The frost is rare in these localities.

[2] JACKY, *loc. cit.* Zeitschr. f. Pflkrkh., Bd. X, p. 141.

[3] A town near the sea-shore.

[4] In February the host withered away without forming any teleutosorus.

[5] HENNINGS, Fungi japonici. V. Engler Bot. Jahrb., Bd. XXXIV, 1905, p. 595.

[6] At a place a little nearer to Kochi he found on the same day only uredosi.

several views may be proposed. JACKY remarked about this point, "es dürfte die Bildung derartig anormaler Sporen vom Standort und der Beschaffenheit der Nährpflanze abhängig sein."[1] That the rust develops differently in Tokyo and Tosa makes it probable that the formation of abnormal spores is due to the influence of the locality where the fungus occurs, but the exact nature of this influence remains still unknown. In Japan the cessation of the development of the teleutospores in the coastal region of Tosa is probably due to the much warmer climate there, but we can not as yet conclude on that account that the climate is the cause of the abnormal formation of spores.

Next we may ask whether the rust on *Chrysanthemum indicum* in Japan develops differently from that on *C. sinense*, as it does in Europe. In Japan I endeavoured to get the specimen of the rust on *C. indicum*, but as most of the cultivated chrysanthemums belong to *C. sinense*, it was not easy for me to find abundant material for study of the rust on the desired plant. However, I was fortunate enough to find a few diseased leaves of this plant[2] in the herbarium in the Botanical Institute, Science College, Tokyo Imperial University. The plant was collected by T. MAKINO at Mt. Hie, Prov. Yamashiro on Nov. 7, 1904. The teleutospores were found abundantly as on *C. sinense*, but neither mesospores nor two-celled uredospores were found, showing that the rust may develop in the same way on *C. indicum* and *C. sinense*.

In this connection I may mention the rust on a wild chrysanthemum, *Chrysanthemum Decaisneanum* Max. This is a coastal plant limited to the warmer region. At the beginning of January, 1907, I collected the rust on it at Hanemura, a coastal region in Prov. Tosa. At that time the host had nearly withered from frost, but the rust was present all over. On bringing it back to Tokyo I found that the sori were almost entirely occupied by uredospores, of which the form, structure of the wall, and

[1] JACKY, *loc. cit.* Centralbl. f. Bakt., Bd. X, p. 375.

[2] *Chrysanthemum indicum* L. var. *genuinum* Max.

the number of the germ-pores did not differ from those of the uredospores of the typical *Puccinia Chrysanthemi*. Exceedingly rarely, I found a few teleutospores whose morphology coincided also with that of the teleutospores of *P. Chrysanthemi*. Moreover, remarkably enough I could find the irregular and two-celled uredospores, and numerous mesospores.[1] So that the rust on *Chrysanthemum Decarisneanum* is quite the same in every respect as that on *C. indicum* in Europe. This gives a strong evidence for the assertion given above that the abnormal development is by no means characteristic of the European rust, but may take place in its native country.

We see thus a great variation in the development of the rust in different localities in Japan. In the coastal region of Tosa irregular and two-celled uredospores are very common, while the teleutospores develop sparingly. In inland localities the rust has a tendency to develop the teleutospores regularly, and inhibit the formation of abnormal uredospores. In Tokyo and its vicinity the formation of these abnormal spores ceases apparently, while the teleutospores follow the uredospores. It also seems probable that the chrysanthemum-rust now so widely found originated from *Chrysanthemum Decaisneanum*, on which the warmer climate brought about the inhibition of the formation of the teleutospores; it then spread to the cultivated chrysanthemum, retaining still the character it has assumed on *C. Decaisneanum*. As it spread wider and wider on the cultivated chrysanthemum in much colder regions it acquired the character of forming the teleutospores on the one hand, and inhibited the formation of abnormal spores on the other. This character has becomes nearly fixed in Tokyo and its vicinity, but in Tosa, where the occasional infection of *C. sinense* by the rust of *C. Decaisneanum* is possible, the character of the rust can still be observed unchanged on the former. That the direct influence of the environment is not concerned on this point may be partly demonstrated by JACKY's infection-experiments.[2] He succeeded in getting

[1] The difference between the sea-shore and inland forms was also described by ARTHUR in *Uromyces acuminatus* Arth. (ARTHUR, J. C., The Uredineae occurring upon Phragmites, Spartina, &c. in Bot. Gaz., Vol. XXXIV, 1902, p. 1).

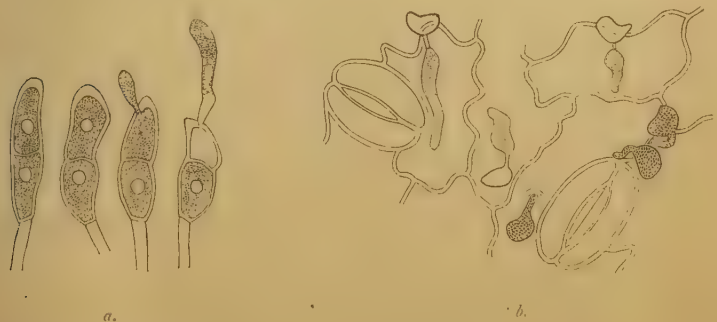
[2] Centlbl. f. Bakt., Bd. X, p. 370.

abundant teleutosori by infecting *C. indicum* with the spores of the Japanese rust,[1] but not with the European rust, which shows that there is no immediate change in the developmental habit of the Japanese rust when transferred to Europe.

The specific name of the host in Europe still remains a question for Japanese botanists. It is there assumed to be *Chrysanthemum indicum*, but if it has all been imported from Japan, we have a strong ground for believing it to be *C. sinense*. The Japanese chrysanthemum with large flowers belongs exclusively to *C. sinense*, though some small-flowered forms belong to *C. indicum*, which is, however, cultivated very little. Hence it is very probable that the host of the rust is the same species in Japan and abroad, being either *C. sinense* or *C. indicum*, so that there is but little doubt about the identity of the Japanese chrysanthemum-rust with the European

White Rust (*Puccinia Horiana* P. Henn.).[2]

This is another chrysanthemum-rust recently made known botanically, though gardeners seem to have been acquainted with it long since. It



a. *b.*

Fig. 1. *a*, teleutospores; *b*. germination of sporidia on the leaf of the host (3 days after sowing). ×400.

[1] The materials were collected by N. Nambu at Urawa near Tokyo on December 4, 1900.

[2] Hennings, P., Einige neue japanische Uredineen. Hedwigia, Bd. XL. 1901, p. (25).

is characterised by having large, white, waxy sori, 2-3 mm. in diameter on the undersurface of the leaf. The sori consist entirely of comparatively small thin-walled teleutospores which germinate as soon as they become mature (Fig. 1*a*). The rapid propagation of the rust is due to infection by the sporidia thus produced. Sown on a leaf of the host kept in a moist chamber, they soon produce germinating tubes which penetrate through the outer wall of the epidermis, and send out swollen haustoria, or intercellular mycelia (Fig. 1*b*). As no spermogonium has ever been found, the fungus should be referred to Leptopuccinia.

The development of this rust proceeds almost without interruption through the year, though its activity varies more or less according to the condition of the host and the condition of the environment. In Tokyo the host-plant suffers most generally in May or June, while it is still young, and the propagation of the rust seems to be exceedingly rapid in a moist place, or where the host-plants are densely planted. The rainy seasons are especially favourable for the development of the fungus: in Tokyo they occur in the spring, early summer, and September. The intimate connection of the development of the rust with moisture is due to the circumstance that the teleutospores and sporidia germinate immediately after maturation.

When the old stems of the host die in the autumn, the rust directly attacks the new shoots, and young and old sori, though not vigorous in development, can pass the winter in the field. There is no doubt that low temperature checks the development of the fungus, but the ripe spores can resist it, and germinate soon when favourable conditions return the next spring.

The white rust is more injurious than the black rust because of its attacking young hosts and of its rapid propagation. However, many forms of *Chrysanthemum sinense* are quite free from its attack. The edible variety of the host-plant called "Ryorigiku" is the one which is most commonly attacked. In the Botanic Garden, Koishikawa, Tokyo, a form called "Kiazami," perhaps closely allied to "Ryorigiku," is also attacked every year. Further, we have observed at several localities that

the rust is found on *Chrysanthemum sinense* Sab. var. *japonicum* Max. ("Ryūnōgiku"), the common wild chrysanthemum. In Tosa it is also found on *C. Decaisneanum* together with other rusts.

Bordeaux mixture is very effective, when used repeatedly, in preventing the propagation of the rust.

Brown Rust (*Uredo autumnalis* Diet.)[1]

This rust is characterised by its light brownish colour. The sori are very small, and appear densely scattered over the surface of the host. In contradistinction to the rusts previously described the sori are produced much more on the upper than on the under surface of the leaves. So far only the uredosori have been observed, but it is probable that they represent a stage of certain *Puccinia*. In external form the present rust is hardly distinguishable from *Uredo Artemisiae japonicae* Diet.[2] widely distributed on *Artemisia*. The character of the uredospores is also like that of the latter rust, having a faintly coloured thin wall. However, in the materials examined by me the sori are not provided with paraphyses, which occurs invariably in *Uredo Artemisiae japonicae*, as Dietel has already observed.[3]

The mode of wintering has not yet been ascertained, but it is most probable that the uredospores can winter without losing their germinating power, as they do in *Puccinia Chrysanthemi* in Europe. This must be quite possible in warmer regions like Tosa where it occurs commonly. In the vicinity of Tokyo the rust is only known on *Chrysanthemum sinense* var. *japonicum*, but in Tosa it occurs on several chrysanthemums, viz. *C. Decaisneanum*, *C. sinense* (cultivated form), and *C. indicum*. From the communication of Mr. Yoshinaga we know that the cultivated chrysanthemums there suffer as much from this as from the black rust.

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[1] Dietel, P., Uredinae japonicae. VI. Engl. bot. Jahrb., Bd. XXXVII, 1905, p. 108.

[2] Dietel, P., Uredinae japonicae. V. Engl. bot. Jahrb., Bd. XXXIV, 1905, p. 591.

[3] Dietel, P., Uredinae japonicae. VI, p. 108.

We see from the observations described above that all the rusts known to occur on *Chrysanthemum* attack *Chrysanthemum Decaisneanum* in Tosa, where they also have a tendency to occur on *C. sinense*, but in Tokyo and its vicinity they show more or less specialisation among themselves with regard to their hosts: thus *Puccinia Chrysanthemi* occurs on *C. sinense* and *C. indicum*, *P. Horiana* on certain garden-varieties of *C. sinense* and on *C. sinense* var. *japonicum*, and *Uredo autumnalis* on *C. sinense* var. *japonicum* only. We also see that the rust on the cultivated chrysanthemum in Europe and that on *Chrysanthemum Decaisneanum* in Japan show no difference so far as their mode of development is concerned. These facts justify our assumption that the chrysanthemum-rusts now occurring on several hosts have originated from *C. Decaisneanum*.

On the Chloranthy of Prunus Mume caused by Caeoma Makinoi.

BY

S. Kusano.

With Plate XVII—XVIII and three Figures in the Text.

Among the numerous instances of chloranthic malformation recorded since comparatively old time (see PENZIG, '90-'94), only a very few cases are known as being caused by parasitic fungi (WIGAND, '56; GOEBEL, '84, p. 123; MAGNUS, '91; SHIRAI, '97; etc), and it appears to me that no special account has ever been given on the close relation between the fungi and the affected flowers in this peculiar class of malformations.

Some years ago I ('06) gave a brief account of *Caeoma Makinoi* and its action upon the host. The fungus infects young buds of *Prunus Mume* and causes a prominent malformation of the organs concerned. Especial attention has been directed to a typical chloranthic malformation. Since immense numbers of instances of chloranthy have already been given from numerous groups of plants, I can not be contented with giving a simple description of this malformation, but I intend to make out, if possible, the close relationship between the cause and the resulting malformation, and thus to throw more or less light upon the etiology of chloranthy. The following statements, though concerned chiefly with this point, will also comprise in part the results of pathological, teratological, and morphological studies.

The observations were made for the last few years mostly in the Botanic Garden of our College, where numerous plum-trees were seriously

affected every year and sufficient amount of fresh material for study was easily available.

Description of the Chloranthic Flower.

We shall first take a full grown affected flower and examine closely the malformations presented by each floral organ.

In the chloranthy under consideration we see that each floral organ preserves its proper relative position unchanged. In a normal flower the receptacle expands, as it were, into a thin-walled cup, carrying on its margin the calyx, corolla, and androecium, the result being a perigynous flower. When diseased, it becomes much thickened and enlarged, and, becoming much shallower, carries the leafy organs in whorls (Fig. 5), as is usual in such cases.

As each phyllomorphic organ increases considerably in size, it forms altogether a large tuft of foliage leaves, which hardly reveals its derivation from a normal flower, which is very small in comparison; and the whole tuft presents a very splendid appearance when an exceedingly large amount of the yellowish-orange spores of the fungus is produced over the whole upper surface of the leaves. Such a monstrous flower is reproduced in Fig. 5, Pl. XVII in its natural colours. It will be seen at once from this figure how much nutrient substances must be drawn upon in the development of this gigantic flower.

Associated with the accelerated growth of the chief floral organs, there occurs a great increase in the length and thickness of the flower-stalk: in a normal state it is less than 2-3 mm. in length and 1.5 mm. in diameter (see Figs. 3, 4), but when diseased, it attains a length of 15-20 mm. and a breadth of 5-6 mm. (Fig. 6), and is provided with well-developed leptomal and hadromal rings surrounding a comparatively large pith.

In describing the phyllody of each floral organ, it may be noted, to avoid misapprehension, that under phyllody we mean here the substitution for the floral organs, not of the ordinary foliage leaves, but of such

deseased leaves derived from a leaf-bud, as were described in a former paper (KUSANO, '06).

CALYX (Figs. 3, 4, 6, 10).

In the normal state, the sepals are, broadly speaking, triangular, adhering to the receptacle with the broader base. As they show the least deviation from the foliage leaf, we may think *a priori* that they can be most easily metamorphosed into the normal leaves, if a necessary stimulus is given. But as a matter of fact, they appear, as far as my observations go, least liable to change, and, to speak more accurately, they assume by no means the form of a normal leaf but retain their proper form, though slightly larger and faintly serrated on the margin. Hence, in the full grown chloranthic flower, they are less easily recognisable in all cases, being concealed under the other much hypertrophied organs. The slight modification undergone by the sepals seems to be due to its being under a similar condition in relation to the parasite as the bud-scales or stipules of the lower leaves of the diseased shoot, which are also least modified. The development of the fungus is quite imperfect in all of them and no cæomasori are developed subsequently to the spermogonia, as is usually the case. This fact seems to lead us to the view that certain anatomical changes of the host are correlated with certain developmental conditions of the fungus, a question which will be fully discussed in a subsequent section.

COROLLA (Figs. 3, 4, 11-13).

The normal petals are nearly orbicular with a short stalk and a diameter of 10 mm. (Fig. 2). They are more subject to complete phyllody than the sepals, and the first step of their transformation into foliage leaves consists in an elongation of the stalk and a gradual expansion towards the upper portion, changing the petal into a blade with an unserrated but irregular margin, of spatulate form and light greenish colour (Fig. 3). After passing through several transitional forms the petal

becomes at length similar in shape to the diseased leaves though much smaller in size.

Frequently it happens that a certain portion, generally the apical, of some petals do not produce the caeomasori of the fungus and shows less deformation than the adjoining portions occupied by the caeomasori. The difference in the degree of the malformation between these portions is always very sharp (Fig. 13). The causal relation between the non-development of the sori and the less deformation of the organs is perhaps an important problem in the etiology of chloranthy.

Androecium.

As the stamen is much more removed in form from the original, the leaf, than the other floral organs, it is natural to expect a greater variation in its phyllomorphic change. Some stamens assume the form of a complete leaf, while others show less deviation from the original form, retaining at times rudimentary anthers or unchanged filamentous portion upon the leafy part.

The several forms thus produced from a stamen will perhaps give a basis for ascertaining the corresponding parts of a leaf and a stamen, inasmuch as a phylogenetic relation exists between the two. Keeping this matter in mind, I shall give in the following detailed account of the malformations, dividing them into six types.

1. *With double blades* (Figs. 14-16).

This anomalous stamen consists of two blades coherent, as it were, with each other by the midribs. The simplest form is shown in Fig. 14, in which the several parts of an ordinary stamen can still be distinctly seen. Here, the basal portion of the filament is slightly flattened and shows the first step in the differentiation of the surface into an upper and an under side, as may be judged from the different mode of development of the fungus on the two sides, the surface with caeomasori corresponding to the upper surface of the leaf. While the upper half of the filament remains, as the figures indicate, undeformed, though slightly enlarged,

we find on its apex, exactly in the place of the anther, four wing-like processes projecting from the portion which corresponds to the connective, two on each side, which are comparable to the front and back walls of an anther-lobe. On these processes we find the caeomasori developing exclusively on the inner surface, which under ordinary conditions would develop pollen grains. This is in favour of the idea that the inner side of the anther-lobes corresponds to the upper surface of the leaf. The relative position of the hadrom and leptom in the veins of the processes also renders it highly probable.

When phyllody goes on separately in the filament and the anther, the blades derived from them become connected with each other by a narrow neck as shown in Fig. 15. This specimen differs essentially from the stamen shown in Fig. 14 in having a completely phyllomorphic filament.

In a more advanced state of change the entire stamen becomes laminar. In this case both blades are always unequal in size; so it appears as if the one accessory to the other which seems to be representative of a primary leaf (Fig. 16), seemingly coherent with their upper surface, as judged from the position of the caeomasori.

Frequently it happens that the major blade has an emarginate apex and looks approximately like a dichotomous leaf which is one of the forms of phyllomorphic stamens (compare Fig. 35). It may be assumed that the double blades mentioned and the dichotomous staminal leaf have been derived by the same series of changes, but in different degrees. The dichotomous leaf would result, if the minor one of the double blades be suppressed.

2. *With a terminal filament upon the double blades* (Figs. 17, 18).

This peculiar form occurs frequently. It differs essentially from the preceding form in having a filamentous or rod-like process on the median extremity of the main blade, forming, as it were, a prolongation of its midrib. Otherwise, in the form and relative size of the two blades, as well as the manner of their connection, the present form agrees with the preceding.

The terminal filament, being slightly flattened, shows a tendency

to assume a laminar structure, producing a few caeomasori on one side and thus showing a dorsoventral differentiation.

In the malformation of a stamen into a bilaminar leaf, it seems to be a general rule that the minor blade is attached to the upper portion of the major one, similarly as may be found also in the petalody of the stamen (CELAKOVSKY, '78, p. 140). Such an arrangement of four lobes on the upper portion of the leaf recalls the morphological nature of the stamen and in particular the homological relationship between the anther-lobes and the two blades.

3. *With two blades and two filaments arranged alternately* (Figs. 19-22).

This is a much more complicated and monstrous form. Probably the change has taken place here in different degrees in the upper and lower halves of the stamen. The lower portion of the filament expands in both longitudinal and lateral directions, assuming the form of a diseased foliage-leaf, while the upper half, attached to the lower surface of that blade by the upper point of its midrib, carries again a smaller blade of irregular form, which may be supposed to have been derived from the unfolded anther-lobes. An equal expansion of each lobe produces a square plane at a right angle to the filament. Further, in the centre of this secondary blade, may arise a short filamentous process which looks like a prolonged connective (Figs. 19, 20).

Broadly speaking, the upper half of the entire staminal leaf under consideration is comparable in its mode of change and in form to an entire leaf belonging to the second form (compare Figs. 17, 18 and Figs. 19, 20). Sometimes it occurs that the upper half of the stamen is so malformed as to form a dichotomous blade which appears to be derived from the anther-lobes and which equally corresponds to some leaves of a similar form derived from entire stamens (compare Figs. 21, 22 and Figs. 35, 36).

In all the staminal leaves thus far described, we see that all the principal parts of a stamen take part in the process. In the first two forms the change has affected almost equally the upper and lower por-

tions of the stamen, while in the last the upper portion has expanded very little, giving rise to a blade which appears as an accessory to the lower one, which now becomes the main blade. At any rate, all these forms agree in that the anther-lobes have made a laminar development.

4. *With a single blade bearing a rudimentary filament* (Figs. 23-26).

In this form only a part of the stamen partakes of the chief transformation into a leaf. The lower half of the filament constitutes the blade of various sizes and forms, and with a longer or shorter petiole, while the upper half including the anther remains unchanged, and is now found on the under surface of the blade projecting out from the midrib. The texture of this part being similar to that of a normal stamen, it soon withers and the blade then appears as if it were derived from an entire stamen.

5. *With a single blade bearing a leafy filament* (Figs. 27-29).

Closely resembling the preceding form, the lower half of the filament chiefly shows the phenomena of phyllody. While in the preceding form the forward growth of the blade went as far as to make the remaining upper abortive filament rest on its central portion, in the present form the upper half of the filament is placed immediately upon the median extremity of the emarginate blade, which exactly corresponds to the lower half of the stamen. The basal portion of the upper half of the filament is yet filamentous, while the upper expands and flattens gradually into a leaflet. Hence the whole phyllomorphic stamen appears as if it were a small petiolate leaflet derived from the extremity of an ordinary leaf by the process called "Ueberspreitung" (Eichler, '86, p. 37, Penzig, '02). When the change advances further, the petiolar part of the accessory blade becomes laminar and both blades are fused together (Figs. 30, 31).

6. *With a single ordinary blade* (Figs. 22-36).

The stamens undergoing the most complete phyllody may be included in this form. A single such stamen is represented by an ordinary petiolate leaf, showing no sign of its real derivation. The form of the blade is very variable. Typically it is oblanceolate or oblong resembling

a diseased leaf (KUSANO, '06, Fig. 11). Among others, of common occurrence is the form with nearly isodiametric blade and with slender long petiole, as shown in Figs. 32 and 33.

The dichotomously parted leaves are not also of infrequent occurrence, usually mixed among the leaves of the first and second forms.

Besides the staminal leaves which can be referred most naturally in the categories above enumerated, there occur intermediate or transitional forms between any two of them.

It may be added here that in a given flower all phyllomorphic stamens seem to give rise, to a certain extent, to the same form (Fig. 5), or, if not, certain form or forms occur predominantly in one and the same flower. This fact shows that in this case the stamens of the same flower, together with the other organs, are subjected equally or nearly equally to the action of the fungus.

The number of leaves appearing in one flower in place of the floral organs is very variable. Since the transformed sepals, petals, and pistil keep, so far as my observations go, to their normal number, the variation will depend upon the number of stamens undergoing the change. Even in a normal flower the number of stamens is not constant, varying from 40 to 55, but the variation is still greater in chloranthic flowers. In one case only 10 phyllomorphic stamens may be developed, while in another more than 60 may be counted. It shows that the stamens may be sometimes abortive or polyphyllic.

An examination of a large number of the diseased flowers renders it probable that there seems to exist a certain relation between the size of a full grown affected flower and the number of its phyllomorphic organs. When the number of leaves is less, their development is vigorous, becoming larger and thicker than when they are more numerous. This relation may depend to a certain extent upon the nutritive condition of the flower-bud, and it is evident that the same quantity of nutritive substances will induce, other things being equal, a better development of the floral organs

when these are less numerous. Generally speaking, the fact that the diseased shoot and flower are somewhat smaller when they occur together in a common axil than when they stand alone, each in different axils. is in support for this view. Further evidence in the same direction may be found in a flower with a gigantic carpellary leaf, represented in Fig. 53, where the floral organs are mostly suppressed.

To show the relation of what have been stated in the last three paragraphs I shall produce a table showing the size of the flower, and the form and number of the stamens developed:

Size of flower.[1]	Number of stamens developed.	Type of phyllody.	Remarks.
Moderate	10	All 4	With short petiole and cleft blade.
Small	10	4, rarely 3	Half the whorls undeveloped; blade greatly cleft.
Moderate	11	All 4	Blade long, cleft; half the whorls unchanged.
Large	16	All 4	Ordinary leaf with oblanceolate form; pistil prolifical.
Large	16	All 4	Stalk short; blade cleft and short; together with diseased shoot; with many staminal leaves not completely developed.
Large	18	All 4	With oblong or lanceolate blade.
Small	25	All 4	Blade small; the peripheral ones cleft, the interior oblong.
Smallest	25	1, 3, 5	Together with shoot; with long filamentous portion in the phyllomorphic anther.
Moderate	28	4	
Small	30	All 4	With large pistillary leaf.
Moderate	30	All 4	Petiolate blade cleft star-like.
Moderate	30	4	
Small	32	4, 5	
Moderate	35	3	
Moderate	35	2, some 5	
Large	35	Mostly 4	With long petiole and cleft blade.

1. By "large" we mean the size as shown in Fig. 5.

Size of flower.	Number of stamens developed.	Type of phyllody.	Remarks.
Moderate	35	4, rarely 3	Blade long, irregularly parted; mixed with small leaves; with seven unchanged stamens.
Small	35	4, rarely 5	Blade lanceolate, stipulate.
Large	37	All 4	Blade cleft and with long petiole.
Small	37	3, 4 or 5	
Large	40	4, 5, 6	
Small	40	All 5	Blade palmate.
Moderate	40	All 4	Blade cleft and with long petiole.
Moderate	40	Mostly 4, some 3	Blade cleft and with long petiole.
Small	40	4, 5	
Large	44	All 4	Together with leaf-bud.
Moderate	44	All 4	Together with leaf-bud.
Large	45	All 4	Blade cleft and with long petiole.
Moderate	45	Mostly 5, rarely 4 and 3	Together with leaf-bud; with long petiole.
Moderate	45	4 and 5, rarely 1	Together with leaf-bud; blade lanceolate.
Small	47	1, 4, mostly 5	
Moderate	50	4, 5	Blade cleft and with long petiole.
Small	50	5, 6	Blade of 6. type lanceolate.
Moderate	52	All 4	Blade cleft and with long petiole.
Large	55	All 4	Blade cleft and with long petiole.
Smallest	55	All 6	Approximataly like ordinary leaf with short petiole.
Moderate	60	All 4	Blade petiolate, with stellate clefts.
Moderate	60	4, few 5	Blade isodiametric and with long slender petiole.
Smallest	62	All 4	Like ordinary leaf, oblong in form.
Moderate	70	All 4	Like ordinary leaf.
Smallest	86	All 4	Blade oblanceolate, prolifical.
Small	?	1, 2	

Gynaeceum (Figs. 51-54).

Generally, the pistil is more liable to show the phenomena of phyllody than the stamen. So in the chloranthic flower of *Prunus*, it undergoes, first of all, a complete change even when the other organs, such as stamens and petals, are somewhat incompletely phyllomorphic. Yet, it may be often the case that the style, when the caeomasori do not appear on it, retains its original shape and character, remaining unchanged on the top of the blade and thus corresponding, as it were, to the tapering apex of a normal leaf. The form of the derived leaf is more or less variable; mostly it is, besides being oblong like a normal leaf, trilobate (Fig. 54), or irregularly cleft, always with a long petiole. Of the lobes of the blade it is a noteworthy fact that the lowest or lower pair attains the largest size, while the others are small (Figs. 52, 53). As a rule, the leaf derived from the pistil is the largest of all transformed organs of a single flower.

A somewhat incompletely phyllomorphic pistil is shown in Fig. 51. On its margin two ovules are represented in an incomplete stage of phyllody; the one on the left (*a*) is a blade rolled up and the other on the right (*b*) a blade parted in two lobes. On the centre of the upper surface of both blades may be seen small papillae representing the nucelli of the ovules.

In connection with chloranthy another related malformation occurs frequently on the androecium and gynaeceum, and we have, instead of leaves, shoots with a short axis and few leaves, representing the prolification of flowers. Such a change is most likely to occur on those flowers that have undergone the most complete phyllody, and therefore it appears that the prolification represents a more advanced stage of malformation due to the parasitic fungus (Fig. 5).

In the diseased flower, in which we have counted 86 oblanceolate, small, nearly perfect leaves in the place of stamens (see Table given above), are developed a few short shoots in the whorl of the androecium, each

carrying two or three oval, stipulate leaflets (Figs. 41. 42). As they arise from the axils of the stamens, the term 'axillary prolification' may fitly be applied to this phenomenon. A similar change takes place more frequently in the gynaeceum, and in this case the term 'median prolification' may be used (Fig. 5). The growth of the shoot is here far more vigorous than in the case of the androecium.

It may be interesting from the etiological point of view that the prolification is always associated with the most complete chloranthy. Since we know that the malformation under consideration is due to the action of a fungus, it may be reasonably supposed that in this case the fungus acts upon the flower at an earlier stage, probably prior to the completion of the embryonal stamen or pistil.

Development of the Diseased Flower-Bud.

It must not be supposed that all diseased flowers are attain such a full development as is described in the foregoing: some of them wither out sooner or later after blooming. To make clear the influence of the various degrees of affection on the fate of the flowers concerned, how far the change can advance in young flowers, and again to get a knowledge of the ontogenetic development of each phyllomorphic organ, we will now proceed to study the diseased flowers in the younger stages of their development. The first question is that of the symptom of the disease first visible in the bud.

At the end of January, the diseased flower-bud shows no external signs of abnormality, being still at rest, small, and compact. Generally, the first indication of abnormality becomes apparent at the time the bud begins to swell up, and the greenish corolla comes in sight. On other points, for instance, the rate of the unfolding of the bud, the time of blooming, and its subsequent growth, the difference between the normal and abnormal flower-buds is not evident. In Figs. 2-4 are represented slightly affected and completely deformed flowers at the beginning of April. The normal flowers have just withered, while the partially affected (Fig.

2), incompletely (Fig. 3) and completely (Fig. 4) chloranthic flowers are nearly like normal ones in size and general form. At this stage the diseased flowers are distinguished from the normal by their pale yellowish colour and the thick texture of the floral organs. The diseased leaf-bud is somewhat accelerated in development: it is in a stage corresponding to that of the diseased flower, while the normal buds remain still closed (compare Fig. 1 and Fig. 3). It is clear from this fact that the gigantic size of the full grown chloranthic flower is due to continued growth till a later period, proceeding at an equal pace with the normal or diseased shoot.

To what degrees the malformation will proceed in a given flower can be told already at the flowering stage or still earlier, so that all the affected flowers can be confidently classified into the three groups, according to the degrees of malformation which they already manifest.

1. Partially affected flower (Fig. 2). It differs from the normal flower to a very slight degree. Only the basal portion of some or all petals and stamens develop the spermogonia. The affected parts are yellowish or pale greenish in colour, and are slightly elongated and thickened, while the healthy parts present the normal appearance. More remarkable is the change of the pistil, which, without losing its general form, becomes elongated and swollen, and is always more hypertrophied than the other organs. It may be noted that in a partially affected flower the organs of the inner whorls are more frequently and more extensively attacked by the fungus than those of the outer. None of the organs of such a flower can develop into a greenish leaf.

2. Incompletely chloranthic flower (Fig. 3). The petals and pistil undergo complete phyllody. But the stamens are not completely deformed: only the basal portion of the filament becomes a narrow blade with serrate margin, and the upper portion, developing quite normally, carries at times a perfect anther containing pollen grains, though in most cases the anther is sterile and greenish, and the connective has become broad. The stamen at this stage is nearly as large as the normal one. The pistil shows separation along the suture line, the hairs covering its whole surface in the normal state are suppressed in development (Figs.

43, 44), and the whole organ looks like a young, rolled-up leaflet (Figs. 4, 49). The apex of such a pistil sometimes bears an imperfect stigma. The spermogonia are found scattered over the whole surface of the floral organ.

3. Completely chloranthic flower (Fig. 4). All the organs are replaced by foliage-leaves. In the stamen the filament and anther become laminar separately or together. Before the unfolding of the bud all the organs look like bud-scales, with the exception of the pistil which projects from the centre of the bud as a young leaf twisted and rolled up. Spermogonia are found on all the organs.

The flowers of the first group, having least deviated from the normal flower, wither soon after blooming. The flowers belonging to the other two groups persist in their abnormality, and can grow further for a considerable length of time (Fig. 5). Thus, examination of the young flowers show that the form which a malformed stamen will assume when full grown, though very complex, is already determined at the flowering stage.

In comparing some partially phyllomorphic organs, such as stamens, or pistils, in the young and adult stages of growth, we notice that the undeformed part of each organ, generally the upper, does not show any noticeable increase of size or other change during the growing period (Figs. 3, 23-26, 49, 51-53). The extraordinary hypertrophy of the most completely phyllomorphic organs is mainly due to the abnormal enlargement of their basal portion which is known to remain meristematic, i.e. capable of cell multiplication, longer than the apical portion. The several forms shown in Figs. 19-29 will confirm this statement.

It follows that the local enlargement of organs takes place chiefly in an incompletely chloranthic flower; but, in general, in the most completely chloranthic flowers, such as is shown in Fig. 4, the organs show a tendency to enlarge uniformly, so that in both the younger and adult stages the form of the leaves is nearly similar, being lanceolate or oblanceolate.

Thus, having distinguished two cases of the enlargement of organs

according as they are in the state of complete or incomplete phyllody, we are inclined to think that the chief cause of this difference is perhaps due to the different action of the fungus according to the time of infection. The uniform enlargement would be hardly possible in those organs, in which the most important differentiation of tissues has been nearly completed, and no or very little meristematic portion is left. If, on the other hand, the fungus should infect the organs at an earlier undifferentiated stage, the mycelium would be able to extend uniformly through the entire organ and give rise to a uniform deformation.

Relation between the Development of the Fungus and the Malformation of the Floral Organs.

Comparison of the diseased organs in young and adult stages leads us to the view that the change brought about by the fungus is different in degree according as the latter develops only spermogonia or both spermogonia and caeomasori. The affected organ already shows a certain degree of malformation at the time the spermogonia appear: the formation of chlorophyll begins, serration is usually found on the margin, and more or less hypertrophy is taking place. At this time the size of the flower is nearly as shown in Fig. 3 and 4. The further enlargement of the organ accompanied by other changes takes place when the fungus has developed so far as to produce the caeomasori, and it is at the time of maturation of the caeomasori that the organ attains full growth. Moreover, it may be observed that, where the sori do not appear, the malformation does not proceed further, but remains in the state in which it was when the spermogonia appeared. Even in full grown chloranthic flowers we invariably see the clearest difference in the degree of malformation between the organs, or portions of an organ, with and without caeomasori. The very slight malformation not unfrequently met with in sepals and some bud-scales, which we have already mentioned, must certainly be closely related with this circumstance of the development of the fungus. The irregularly shaped phyllomorphic petals, such as are shown in Figs. 11-13 seem to bring out this relation more clearly. The portion occupi-

ed by the spermogonia is thin, and often has a reddish tint with less chlorophyll, while that occupied subsequently by the caeomasori is very thick and pale greenish. These characters are sharply demarcated from each other on the boundary line between the two portions. In the figures mentioned, the portion occupied by the caeomasori appears to have developed mainly after the maturation of the spermogonia, showing secondary growth. The asymmetrical forms shown in Fig. 11 and 13 are certainly due to such growth having taken place unequally on both sides of the basal portion, while a uniform growth of this portion would result in a symmetrical form (Fig. 12).

A similar relation is also found in the pistil. Caeomasori are sometimes absent on the style, and the latter is then but slightly modified, retaining sometimes its original form and bearing a stigma. To the same cause is also due the frequent presence of undeformed filaments on the leafy portion of a transformed stamen (Figs. 23-26).

It still remains to inquire into the causal relation between the different degrees of malformation and the mode of development of the fungus. Is the condition of the fungus itself leading to the production of caeomasori the direct cause of the advanced malformation, or is the production of caeomasori correlated with such internal condition of the host as to bring about advanced malformation? In my opinion, the chloranthic malformation in question is doubtlessly due to the action of the fungus, but the degree of malformation may be determined by the internal condition of the affected organ itself. While it is believed that the production of the caeomasori is a proof of the vigorous development of the fungus, for which the affected organ must provide a sufficient amount of nutritive substances, it is quite certain that the fungus would be unable to produce the sori, were the organ not responsive to this new condition of the fungus. A great hypertrophy of the organ or its part, which is always associated in the present case with the more advanced malformation, shows that it is capable of the multiplication of cells. When we remember the fact that the upper portion of an organ is less subjected to malformation than the basal portion where the multiplication of cells and the consequent

hypertrophy as well as the production of caeomasori can take place more easily than in the former, the malformation seems to depend directly on the state of the organ or its portion: while the basal portion is still meristematic, the fungus can irritate it by its development so as to cause hypertrophy. In short, the development or non-development of the caeomasori must be ascribed to the condition of the affected portion and the same condition gives rise to different degrees of malformation.

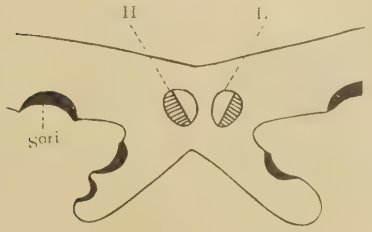
Malformation of the Anther.

From the chloranthic flowers we have obtained several forms of deformation in the upper portion of the staminal leaf. The gradual transition from one form to another expresses, in my opinion, the different degrees of abnormal development of the anther. Believing this direction of the abnormal development of the anther to be parallel to that of the phyllomorphic malformation of other organs, it may be proposed that the several forms presented by the anther afford some evidences for its morphological value, assuming that teratological data may be made a basis for morphological study[1]. As to the morphological value of the anther several conflicting views are held at present. This conflict of opinions is chiefly due to a different valuation by different writers of the chief evidences on which their views are based. From the historical review of Masters ('69) and Celakovsky ('78) we see that some older writers believed the loculi of the anther to have been derived by excavations of the leaf parenchyma, at the marginal portion, on both sides of the blade, two on the upper and two on the under surface, while the margin itself became the suture of the anther; while some botanists hold the view that the connective corresponds to the median portion of the staminal leaf, the loculi being derived from the lateral portion of lamina, by a diminution of its length and breadth, and an increase of its thickness. A. Braun's ('76) opinion as to the formation of the anther, afterwards sup-

1. I leave the discussion of this fundamental point to such recent writers as Goebel ('98, p. 153) and Velenovsky ('05, p. 15), who hold opposing views.

ported by WYDLER, is that the blade becomes 4-winged by enation, the upper two wings being newly enated, while the lower two are parts of the primary blade, and each two wings on the two sides form one half of the anther. On the other hand, SACHS ('82, p. 541) holds a quite different view that the parts of the stamen corresponding to a leaf are the connective and the filament, and the anther-lobes are produced in some cases at least secondarily as an appendage. Of recent writers CELAKOVSKY ('78, '84) adopts BRAUN'S theory, ENGLER ('75) and VELENOVSKY ('10, p. 939) agree with the older botanists, while GOEBEL follows SACHS.

Taking into consideration the facts obtained by the present study, we are inclined to the view of the "Verdoppelung" of the anther, and are strongly in favour of BRAUN'S theory. In the phyllomorphic stamens shown in Figs. 14, 19-22, we find a leafy structure in the place of the anther, which I assume to represent a metamorphosed anther. Likewise I am of the opinion that the bilaminar structure at the apex of some phyllomorphic stamens (Figs. 15-18) is produced by an abnormal development of the anther. Bringing these structures together we may perhaps conclude that each two wing-like processes of the bilaminar leaf exactly correspond to each anther-lobe, as BRAUN mentioned. Fig. 14, which shows a slight degree of phyllody, will amply justify this statement. Also there is no doubt that the small four-lobed blade in Figs. 19,20 represents an anther or anther-lobes. If the phyllomorphic change goes simultaneously in the filament and anther, a bilaminar leaf would result (Figs. 15-18). Taking together such bilaminar leaf and the dichotomous leaf (Figs. 35, 36) found in the most completely chloranthic flowers, it appears that there is a close genetic relation between these two forms. The minor blade in the bilaminar leaf corresponds to the inner halves of the two lobes in the dichotomous leaf, the former being formed from the latter by the bulging out towards the upper surface. The evidence in favour of this view and against the view that the bilaminar structure is formed from two different leaves, minor and major, fused together along the midribs will be found in the arrangement of the bundles at the junction point of the four wing-like processes, as well as the dis-



Text-fig. 1.

tribution of the veinlets in the latter. In a cross-section through the bilaminar portion we find two vascular bundles at the junction point. As shown in Text-fig. 1, they are arranged side by side with the hadrom (H) on the outside and facing each other with the leptomal portion (L). The veinlets originating from one of them enter both the minor and major wings on the same side, showing that the minor and major wings on one side represent in fact the lateral halves of a blade, whose midrib is probably represented by one of the vascular bundles. When the malformation advances further, the four wing-like processes pass into the four-lobed blade (Figs. 19, 20) and the latter in turn into the dichotomous blade (Figs. 21, 22).

Taking the relative position of the leptomal and hadromal portion in the vascular bundle of the blade and the position of the cacomasori on the blade into consideration, it may be concluded that the inner wall of the anther-lobe corresponds to the upper surface of the leaf, if we admit, according to the view above set forth, that the anther-lobe is produced by the bulging out of a leaf at its apical portion.

Cases of bilaminar malformation have been reported in the ordinary leaf. Masters ('69, p. 446) gives an instance in the orange tree, in which some leaves presented the appearance of having been formed by the fusion of two leaves back to back and with the vascular bundles in the common midrib arranged in a circular manner and not in a horse shoe-like arrangement. Buchenau ('88) describes a four-winged leaf in tobacco, which is formed, according to his explanation, by an exces-

cence of the blade. A. Ernst ('99) gives two instances of laminar enation. In *Anthurium* he found a boat-like adventitious lamina on the under surface, arising midway between the primary nerves with its inner surface corresponding in its structure with the upper surface of the primary lamina. He ascribed this malformation to the bulging out of the internal tissue towards the under surface of the leaf. In a mango-leaf he found also a secondary leaf of a little boat-like shape on the under or upper surface of the primary leaf, adhering with its keel to the midrib of the latter. According to his statements, the secondary leaf has a median nerve which is proved evidently to be a piece of the outermost fibro-vascular bundles of the original costa. If I understand him aright, the secondary leaf, differently from what we saw in *Prunus,* seems to have its veinlets originating from the median nerve, while the original costa ramifies in the primary blade. We see in these cases that the mode of formation of the accessory leaf is different from that of the bilaminar staminal leaf, and so we can not consider the given malformation of the anther as an abnormality without regularity as is usually assumed in similar malformations of the ordinary leaf.

In the present case the malformation of the anther goes on in different ways according as it undergoes phyllody or petalody. In the so-called double flower (*flores pleni*), the petalody of the stamen is simpler than the phyllomorphic change, the anther-lobe taking no essential part in forming petaloidal stamens. As the first step of the change, there appears a small ligule projecting from the apex of an ordinary anther, which appears to correspond to the expanded connective. When the change proceeds further, the ligule becomes larger and larger, till it assumes a petaloidal appearance as well as form, while the anther-lobes are borne on its upper surface in an abortive form. The filament becomes more and more laminar, and in a completely petaloidal stamen it constitutes the lower part of the petal (Figs. 37-40). Essentially similar changes are found in the petalody of the stamen of *Camellia japonica* (Celakovsky, '78; compare his Figs. 14-35).

Malformation of the Ovule.

In a full grown and completely phyllomorphic carpellary leaf, we can hardly point out the portion corresponding to the ovule. But in some chloranthic flowers, there are found at young stages some carpels in various degrees of malformation, which appear to me to throw light on the morphological value of the ovule.

In general, the degree of change of the ovule seems to correspond to that of the pistil to which it belongs. Examples of the least deformed pistils are shown in Figs. 2, 44, and 45. Compared with an ordinary pistil (Fig. 43), the essential external difference lies in the hypertrophied, fusiform ovary; the malformation is little advanced, and the outer surface is covered with the same hairs that characterise the normal pistil. Opening such a pistil longitudinally, we find certain changes inside the ovary. A pair of much hypertrophied ovules are developed on the ligulate process appearing along the ventral suture line (Fig. 45). Below them may be seen a pair of serrated processes. The whole condition probably represents the first step of phyllodic metamorphosis.

The next stage of malformation is found in a similarly deformed pistil (Fig. 46). There is nothing important in its outer appearance that distinguishes it from the foregoing, but the ovules, instead of being solid cell masses, are here represented each by a slightly parted lobe, which however looks, when rolled up, like a solid ovule as before. In the centre of such a lobe is found a small papilla (Fig. 47). A full grown ovule in a similar state of malformation is often found in a completely phyllomorphic carpel (Fig. 51), and in such cases the division of the ovule into the outer laminar part and the median papilla may be most distinctly seen. On tracing back the steps through which the ovule has passed in this process of malformation, we find that the papilla corresponds to the nucellus and the laminar part to the primine (integument), and that the laminar part has a tendency to hypertrophy, while the papilla shows the opposite tendency.

The most advanced malformation so far observed in a closed carpel is shown in Fig. 48. The lamellar process developed along the suture is more prominent than before, and the position of the ovule, or the portion of the process corresponding to it, is not easily discernible. We are inclined to the view that the lamellar process or processes developed both above and below the ovules, as shown in the preceding figures, approximately represent the margin of the leaf, while the laminar ovules have themselves undergone similar changes, so as to bring ultimately the differences between the two parts to nil.

A more advanced stage of the malformation of the pistil is shown in Fig. 49. Though the general form does not differ from those of the preceding examples (Figs. 44-48), the ventral suture shows a slit, and the margin of the carpel becomes visible externally. Opening this carpel we find a pair of bifurcated lobes at the place corresponding to that of the ovule (Fig. 50). As such a carpel is found in completely chloranthic flowers, I am sure that it can develop later into a completely phyllomorphic leaf, such as is shown in Fig. 52 or Fig. 53, where the marginal lobes that have replaced the ovules can still be pointed out. It may be noted that the bifurcation of the ovular lobes is already apparent at a very early stage of development and remains so until a somewhat advanced stage (compare Fig. 50 and 53), and the single lobe found in place of the ovule (Figs. 52, 54) indicates probably the form more advanced in phyllody than the bifurcated one.

In the most completely phyllomorphic carpel the ovular lobe becomes less conspicuous and finally indistinguishable from the serration of the margin. This is so not only in the adult leaf, but already in a young stage, as shown in Figs. 3, 4.

The series of transitional forms between the normal and malformed ovule above described, in which the ovule appears first as a lobe on the carpellary leaf and, becoming generally less prominent, finally forms an integral part of the carpel, will justify us in concluding that the ovule in fact undergoes the phyllomorphic change during the metamorphosis of the carpel.

Keeping this fact in mind we will inquire shortly into the morphological nature of the ovule and its covering. Indeed this is a difficult problem, and various conflicting views are still prevalent among eminent botanists. According to WORSDELL's ('04) review of this subject, the various published opinions may be classified into three classes, viz. (1) the axial, (2) the foliar, and (3) the *sui generis* theory. The augments advanced in support of these theories are based essentially on the developmental, comparative, anatomical, or teratological studies of the ovule, or on a combination of them, and the different opinions of the authors seem to depend on the comparative weight which they attach to different data. I have no intention of generalising my observations on *Prunus* into a theory, but if we once admit the value of teratological evidences in this case, as CELAKOVSKY ('84) so earnestly contends for, there is no doubt that the facts presented above agree best with the foliar theory[1]. For, we have obtained several transitional forms from the entire ovule to the marginal lobe of the carpel and even from the lobe to the serrated condition. Hence, if the malformation in this direction be taken as of equal weight as the phyllody of the pistil, in determining its morphological nature, we are led to look upon the ovule as a process or lobe developed from the margin of the carpellary leaf, and not a new growth or bud. The lobe derived from the malformed ovule corresponds to its integument, while the nucellus, the reproductive organ proper, is replaced by a small papilla which undergoes complete atrophy when the malformation advances further. The nucellular portion leaves no corresponding portion on the phyllomorphic carpel: it may therefore perhaps be a new growth.

Etiological Considerations on Chloranthy.

Having given a detailed account of the possible changes of the flower caused by *Caeoma Makinoi*, we shall now proceed to consider, from the

1. A historical sketch of the various views on the morphological nature of the ovule is given by WORSDELL ('04) in a concise but very comprehensive form.

the etiological point of view, the relation between the development of the fungus and the chloranthic change. Respecting the cause of this change in general, several views have been expressed by different authors. Some (FRANK, '81, p. 436; GOEBEL, '84, p, 124; SORAUER, '09) maintain the view that plants are inclined to undergo chloranthic or similar pathological malformation when subjected to excessive humidity or nutrition. This view agrees to a certain extent with the phenomenon that the overnourishment of the vegetative organs generally tends to inhibit the formation of the reproductive organs, leaf-buds, for example, replacing flower-buds. MASTERS ('69, p. 280) has already remarked, "It might at first be supposed that the same causes that bring about the complete substitution of leaf-buds for flower-buds would operate also in the partial substitution of leaves for other parts of the flower, but it will be seen that the inducing cause, whether similar or not in the two cases respectively, acts at different times; in the one case, it is not brought into play until the rudiments of the flower are already formed, whereas in the other the influence is exerted prior to the formation of the flower. So that while the formation of leaf-buds in place of flower-buds may be and generally is due to an excess of nutrition, inducing overactivity of the vegetative organs, the production of phyllomorphic or chloranthic flowers may be owing rather to a perversion of development arising from injury or from some debilitating agency. The discrepancies in the assigned causes for the conditions above mentioned may, therefore, in great measure, be attributed to the different periods at which the causes in question operate." In studying the tuberous change of flowers in a *Nymphaea,* BARBER ('89, p. 113) holds a similar view as its cause. Thus, according to the last mentioned two authors, the important factor for chloranthic change is the period at which a certain cause operates, and, therefore, the cause which perverts the formation of the flower may equally give rise to chloranthic flowers, if it operated later.

In a great majority of cases, chloranthy is caused by a certain physiological disturbance prevailing in the whole plant body, whereas the time or duration of the action is not clearly conceivable. The question

is, however, quite different when the initial change is due to parasites, whether insects[1] or fungi. In these cases there is clearly a time and spatial relation between cause and effect. The study of the close relation between the parasite and the induced change seems, however, to have been neglected. Peyritch ('83) first made an experimental study of the chloranthy caused by the attack of an insect. After numerous experiments he came to the results that the degree of the change produced is proportional to the number of the insect concerned and the period of infection of the flower-bud. Even with this valuable investigation the extent of the stimuli of the insect is not yet thoroughly clear. As to the intimate cause of the general malformation of flowers, the hypothesis of Sachs ('93, p. 236) may be mentioned that the formative substances of floral organs, which are produced by the leaves and determine definitely each floral organ, are in normal development distributed with mathematical accuracy to still embryonal organs; but "Abnormitäten", he says, "dadurch hervorgerufen sein können, dass in der mikroskopische kleinen jungen Blüthenknospe einige organbildender Substanz einen unrichtigen Weg genommen oder zu spät oder zu früh eingewandert sind u.s. W." Goebel ('98, p. 174) seems to hold a similar view concerning certain kinds of malformation.

The first question to be considered in the chloranthy before us with regard to the relation of the fungus and the malformation is that of the distance to which the action of the fungus may extend in the surrounding tissue. It is known that in the branch of the witches' broom, usually caused by parasitic fungi, the leaf-bud is substituted for the flower-bud. In this case, the mycelia traverse the whole diseased branch, so that any abnormal development seems to be correlated with the whole organisation of the broom. An important point of difference in the present case is that the fungus development is generally limited to the bud, and the abnormal development of the latter is to be assigned to the

1. Numerous instances of the phyllody of some floral organs caused by animals are enumerated by v. Schlechtendal in "Die Gallenbildungen 1891."

mycelium found in its tissue. Even in a floral organ attacked by the fungus the phyllomorphic change is sharply limited to the region occupied by the mycelium; for instance, a portion of the affected corolla remains quite healthy, if it is not invaded by the mycelium (Fig. 2). It appears highly probable that the infection of the floral organ by the fungus is by no means the necessary cause of phyllody; the malformation is observed only in those parts which are traversed by the mycelium.

As we have already stated, the degree of malformation is correlated with the mode of the fungus development. Although it appears that the intercellular mycelium would determine, first of all, an alteration of the course of development of the floral organ or its portion leading to phyllody, the subsequent development of the latter, attended by corresponding malformations, must be associated with the manner of the fungus development. Were the fungus under condition incapable to complete its development, the phyllomorphic change is less remarkable. On the other hand, typical malformation always accompanies the formation of the caeomasori. This fact gives us the impression that the stimulus of the fungus is stronger when the caeomasori appear.

The most important point to be considered from the etiological point of view is the period of infection of the fungus. The bud may be infected rarely by the perennial mycelium and, in the majority of cases, by the spore. Internal infection by the mycelium takes place, when a bud occurs within the extent of the intercellular mycelium which has spread up and down, chiefly through the cortex, from the node where an affected bud was developed the preceding year. In the case of external infection it is still obscure what kind of spores effects it, since the life-history of the fungus is not clearly known; so that the period of infection can not determined accurately. On the other hand, I think that some ideas on the subject may be formed from a consideration of the behaviour of the perennial mycelium.

Among the flower-buds appearing successively at different distances from the node, the bud of which was affected the preceding year, and from which the perennial mycelium has spread out through the cortex

of the stem, chloranthic malformation is seen only in a certain number of them lying near the node. Of these, again, the degree of malformation decreases successively from the bud nearest to the node to the one lying farther from it. Keeping in mind that the diseased bud, whether weakly or strongly affected, must be, as already stated, always invaded by the fungal mycelium, and considering that the arrival of the mycelium in each bud occurs at different times, it can be conceived that the difference of malformation they exhibit is due to the different periods of infection. This view is supported by the peculiarities of the diseased branches shown in Text-fig. 2.

Text-fig. 2.

The branch A was infected by the fungus the preceding year at the node 1, and the flower (*f*) and shoot (*s*) derived from it were affected. Above and below this node the stem shows a slight swelling, and a longitudinal fissure (*r*) is produced on the cortex, extending to the node 2. The cortex is here traversed by the intercellular mycelium which sends

out, at intervals, cystolith-like haustoria in the surrounding cells (KUSANO, '06). The mycelium, proceeding further up the branch from the node 2, reaches a higher flower-bud on it. The bud develops a flower in partial chloranthy: healthy whitish portions are seen on the petals, the stamens carry normal anthers, and the pistil has a closed ovary. The flower on the branch from the node 3 upwards is quite healthy, as it lies beyond the reach of the mycelium.

Similar facts may be seen more clearly in the branch B. It was infected the preceding year at *a*. In the same year a healthy flower was developed at *b* and also the normal shoots, x and y. The mycelium entered the branch at *a* and has thence spread up and down through the cortex and caused an abnormal thickening of the branch, more markedly at *a* and *b*. The fissure in the cortex extends in the shoot x beyond the bud *g*, and in the shoot y below the bud *d*. The buds of these shoots are affected in different degrees. The bud *c*, which appears, from its position on the shoot, to develop into a flower, shows the greatest distortion, and gives rise to a diseased shoot. The symptom of its affection was visible already in January by its unusual enlargement and by having succulent loosely over-lapping bud-scales. It is certain in this case that the mycelium has invaded the bud when the rudiments of the floral organs, which would be formed under normal conditions, were still undifferentiated, and thus inhibited its development into a flower. The bud *d* on the next node develops a completely chloranthic flower: in the embryonal form the stamens and pistil are entirely leafy. The change is incomplete in the bud *e*, developing an imperfectly chloranthic flower. Lastly the bud *f*, lying beyond the reach of the mycelium, grows into a quite healthy flower. Something similar is observed in the shoot x: a completely chloranthic (*g*), incompletely chloranthic (*h*), and normal flower (*i*) are arranged successively in the lower and the upper portion of the shoot.

It is very evident that the extension of the mycelium from the infected point is gradual, and the more proximal buds are infected earlier than the more distal ones. The incompletely chloranthic malformation

of the flower on the distal portion is, therefore, due to a later infection by the mycelium, the infection having taken place after the rudiment of each floral organ had already been formed. It is also quite natural that, if the mycelium invade the bud at the time when it embryonal processes are not yet differentiated into floral organs, a diseased shoot (*c*) would appear from it, while a slightly later infection makes the foliage leaves derived arrange in whorls as the normal floral organs.

I may here make an attempt to determine the exact time of the year when the mycelial infection of the bud is efficient enough to cause chloranthy. According to MASTERS' view and from the facts we have just referred to, it may be inferred that the question would be solved, if the period at which the embryonal processes in the bud are definitely differentiated into floral organs be accurately ascertained. So far as has been observed in Tokyo, this period is attained before the vegetative season is over; in the autumn (October) the rudiment of the floral organs are already formed distinctly and arranged in whorls. Hence, if the mycelium should begin to exert its malforming action for the first time at or after this period, the infected flower can not show anything else than incomplete chloranthy, developing, for instance, such staminal leaves as are shown in Figs. 23-26.

Again, in the early part of the vegetative season (June or the end of May), while the new shoot is yet at the growing stage (Fig. 5), the rudiment of the winter bud is not visible, so that, if the mycelium should at this period reach the axil of a leaf, the bud to be developed there subsequently would be primarily affected, and produce a shoot instead of a flower. From these observations it may be concluded that the period of infection by the mycelium, necessary to cause typical chloranthy, is between the late summer and early autumn, most probably in September or August.

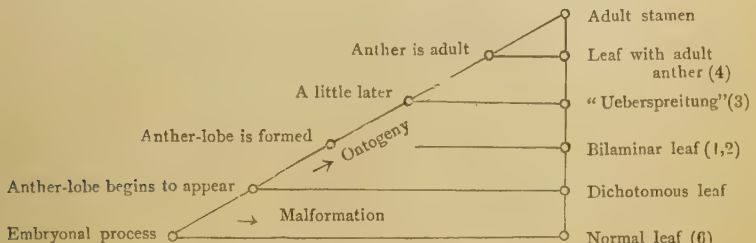
Turning again to the branch B in Text-fig. 2 with this consideration in mind, we may make the following statement about the development of the mycelium through the mother-branch of the buds as follows:

While the affected bud at *a* is growing into either a chloranthic flower or a diseased shoot and its sister-buds are being developed into the normal shoots x and y, the mycelium at *a* begins to spread with great rapidity. It is in June or July that the mycelium invades the basal portion of these shoots, where the rudiment of the bud is not yet formed. The bud *c* is perhaps formed after the arrival of the mycelium. The arrival of the mycelium at the nodes *d* and *g* takes place still later, perhaps in August, when the buds have already developed far enough to form the floral organs. Further, it may be assumed that the buds at *e* and *h* have advanced in normal development so far, previous to infection, that the subsequent action of the mycelium is no longer efficient to produce complete phyllody.

In the chloranthy due to external infection by the spore, we can find also several forms of malformation. Leaving the question as to what kind of spores the infection is due to for further investigation, I may at present propose the view that the period of infection, or strictly speaking, of the beginning of the malforming action, must be the same as in the case of the mycelium. The spore attaches itself to the axil of the growing shoot and germinates there in June or still later. Some spore may germinate previous to the formation of the bud-rudiment, while some may germinate after the bud has formed the embryonal floral organs. According to the earlier or later germination of the spore, we will obtain from the affected bud a shoot instead of a flower, or a completely or incompletely chloranthic flower.

The conception we have thus developed as to the relation between the degree of malformation and the period at which the perverting action of the fungus begins may also be drawn from a chloranthic flower itself, by considering the different amount of change exhibited by the phyllomorphic stamens mentioned before. The staminal leaf with the upper half of the stamen unchanged may be the result of an infection which took place at the moment when the proper form of the stamen was nearly completed, but a meristematic portion was still left at its base, the mycelium having attacked this meristematic portion. A slightly earlier

infection would result in the formation of a structure with four wing-like processes in place of the anther. On the other hand, a complete phyllody will result when the fungus begins to act upon the stamen while it is still an undifferentiated process. On the whole, we agree with GOEBEL (98, p. 155) who says, "Es kommt also bei der Umwandlung von Staubblattanlagen in Betracht erstens die Entwicklungsstufe, auf welcher die Staubblattanlage steht zur Zeit, wo sie den Antrieb zur Umwandlung—wenn dieser Ausdruck gestattet ist—erhält, und auf die Grösse dieses Antriebs." Hence the several forms of the malformed stamens mentioned in the foregoing are the results of infection at different stages when the normal development of the stamen became affected. This relation may be represented in the following diagram[1]:



From this arrangement we can see that the phyllody of the stamen, at least in the present case, is not a capricious monstrosity, but that the several forms of the malformation appear to be exaggerated representations of the forms which the stamen assumes at different stages during its ontogenetic development.

The evidence that the degree of malformation is associated with the stage of development, at which the perverting action begins, is also afforded by the different organs of the same chloranthic flower. As the lower member of the floral organs precedes in development the upper one, it happens that, when the upper members is in the meristematic condition

1. Arabic numerals in the diagram give the types of phyllomorphic stamens described before.

at the time of infection by the fungus, the lower one has already passed on to a more advanced stage, and offers a greater resistance to the malforming action, the result being that lower one suffers a lesser degree of malformation. So in any chloranthic flower the pistil is more advanced in phyllody than the stamens, or the stamens than the petals and sepals (Fig. 3). Again in a lately infected flower (Fig. 2), we see that the pistil shows the greatest malformation, while the stamens or petals present only a slight deformation in their basal portions. Further, among the stamens, those of the inner whorls show a greater degree of malformation than those of the outer; for instance, bilaminar or dichotomous leaves inside the ordinal simple leaves, the leaves with phyllomorphic anther-lobes inside those with the anther and the upper portion of the filament unchanged, etc.

Lastly we will consider in connection with our subject the less affection of the bud-scales. That the outer scales, in most diseased buds, are free from the attack of the fungus is certainly due to the completion of its development before the fungal infection. Though the inner scale is usually affected, even at an early time, its subsequent development is completed prior to the beginning of the next vegetative period, in other words, before the vigorous devlopment of the infected mycelium begins, and hence a slight malformation results. The infection of the bud occurs too late to induce an abnormal development of the scale, and if the infection takes place at a sufficiently early period so as to induce on the scale a notable malformation, the bud would never become a chloranthic flower, but would develop into an affected shoot, as in the case of the bud *c* in Text-fig. 2.

On the basis of these facts I may conclude that the fungus shows in its chloranthic action a certain parallelism with some insects. According to PEYRITCH ('83), the degree of the changes, similar to those dealt with in this paper, of *Arabis* flower when attacked by an *Aphis* depends upon the stage of its development, at which the insect becomes parasitic, and also upon the number of the insect found on one flower. His conclusion is based on the observation of the changes which the flower

passes through, when various numbers of the insect are placed on it at different stages of its development. Although I was not able to carry out a similar experiment with the fungus, yet the careful observations of numerous diseased flowers, especially such as are shown in Text-fig. 2, are, in my opinion, sufficient to justify a conclusion which is in strict accordance with PEYRITSCH's view respecting the degree of malformation in relation to the developmental stage of the affected flower. As to the intensity of the stimulus, he placed the principal weight upon the number of the insect, but I have to compare with it the condition of the development of the fungus: the same condition that inhibits the formation of caeomasori produces a slighter degree of malformations.

As PEYRITSCH has pointed out, a too late infection does not produce chloranthy. The same may be true for the fungus parasite, if we assume that, in the case of the insect, the more developed flowers do not respond to the stimulus of the insect, while in the case of the fungus, the flower at the corresponding stage does not allow the fungus to spread further through its tissue and consequently to exert a stronger stimulus.

In our case chloranthic change goes hand in hand with an extraordinary hypertrophy. The flower must be overnourished. Whether there is causal relation between the two phenomena is at present not certain. It may, however, be that, under these conditions, the fungus is able to develop more vigorously and to exert a stronger stimulus.

General Remarks.

The chloranthy of *Prunus Mume* is due to the action of the fungus parasitic in the flower-bud. The protoplasm of the undifferentiated organ reacts to the stimulus exerted by the mycelium and the course of development is modified in the way mentioned. The stimulus of the mycelium for causing chloranthy is very limited in extent. The development of chlorophyll, attended by other external and internal modifications of the floral organs, extends *pari passu* with the extension of the mycelium. A strong malformation is correlated with a vigorous development of the

fungus, so that, when the conditions are such as to inhibit the full development of the latter, the infected portion of the flower undergoes less malformation.

Complete chloranthy does not result unless the necessary action of the fungus operates upon the bud at a certain stage of its development. Its operation at earlier stages develops the bud into a shoot, while at later stages it produces incomplete or no chloranthy.

The eminent morphologist VELENOVSKY ('05, p. 20) has distinguished the abnormalities occurring in plants into a few categories[1]. According to him, the present instance should be included in the pathogenetic abnormality, since he defined it as being caused by insects, fungi, wound, or injurious chemical agents. However, he admits that "alle vergrünten Blüten" (p. 24) belong to the category of the morphological abnormality, on which he places considerable importance in developing his views on the morphological nature of plant organs. It seems, therefore, that the malformation of anthers and ovules presented by our chloranthic flower may be a welcome addition to our knowledge of the morphological nature of these organs for those who, like VELENOVSKY, attach much weight to abnormalities in the question at issue. As for myself I look upon abnormalities discussed above as atavistic phenomena, and am of the opinion that chloranthic flowers throw some light on the morphological nature of floral organs in general.

Reviewing now, as a whole, phenomena of the chloranthy and the associated changes caused by the fungus, the relation between the time of infection and the degree of the ensuing malformation will become very apparent. This may be easily seen from the following series of diseased buds and their derivatives thus far obtained by me:

a. Bud looks like a normal leaf-bud, outer bud-scales attacked by the fungus; develops into a shoot.

b. Bud swollen just like a flower-bud, outer scales healthy; develops into a shoot.

1. "Pathogene, Extrem-, durch Wurcherung entstandene und morphologische Abnormitäten."

c. Bud swollen just like a flower-bud, inner scales look like sepals; develops into a shoot.

d. Chloranthic flower: axillary and median prolification.

e. Chloranthic flower: stamen into dichotomous or simple leaf.

f. Chloranthic flower: stamen into bilaminar or double leaf.

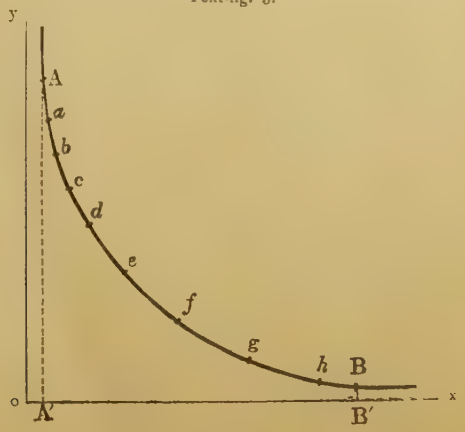
g. Chloranthic flower: stamen into a leaf whose upper half is unchanged.

h. Partially affected flower: slight change in the basal portion of each floral organ.

In *a*, which otherwise would have developed into a flower-bud, the infection takes place at the earliest stage, and in *h* at the latest stage, of the development of the bud. A still later infection than in *h* is not effectual, since the floral organs have become resistent to the attack of the fungus.

The several degrees of malformation mentioned above lead me to say that the change is greater if the time of infection is earlier, and smaller if it is later. Denoting now the time of infection by x, an earlier infection being expressed by a small value and a later infection by a large value of x, and the amount of change by y, we may say that y is inversely proportional to x, that is, $y=\frac{k}{x}$ or $xy=k$, where k is a coefficient.

Text-fig. 3.



It is seen from this equation that the change caused by the fungus is expressed by an hyperbola whose asymptotes are $x=o$ and $y=o$, assuming k to be a constant[1]. So that, in the supposed curve (Text-fig. 3) greater change lies near the point A and less change near B. That a too early and too late infection brings always results in a constant change, the former giving a shoot and the latter a normal flower, is evident when we note that the decrease or increase of x beyond a certain limit (A' and B') gives nearly a constant value of y. This assumption is not inconsistent with the nature of hyperbolic curve, since the curve cuts the asymptotes at an infinite distance; in other words, the extremities of the curve run parallel to the asymptotes.

1. The coefficient k may be variable according to the conditions of the development of the host and fungus, or of the environment. We assume here all these conditions to be constant.

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1. The asterisk marks those to which I have not been able to gain access.

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*WIGAND, A. ('56): Beiträge zur Pflanzenteratologie. Flora, Bd. 39, 1856.
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EXPLANATION OF PLATES.

All figures were drawn from fresh materials and, except Figs, 45–48, 50, are reproduced in natural size.

Plate XVII.

Fig. 1. Young diseased shoot with some inner bud-scales carrying spermogonia.

Fig. 2. Partially affected flower, not essentially deformed.

Fig. 3. Young chloranthic flower having partly phyllomorphic stamens, three normal flowers already pollinated, and three normal leaf-buds.

Fig. 4. Young chloranthic flower having completely phyllomorphic stamens and affected bud-scales.

Fig. 5. Chloranthic flower in full growth, young fruit, and normal shoot, all developed on a shoot of the preceding year. The yellowish-orange caeomasori have densely covered the upper surface of all the blades of the flower.

Plate XVIII.

Fig. 6. Much hypertrophied stalk of a chloranthic flower with diseased bud-scales at its base.

Fig. 7. Outer healthy scale of a diseased leaf-bud.

Figs. 8, 9. Partially affected inner scales of the same, a slight thickening taking place at the portion occupied by the spermogonia.

Fig. 10. Slightly phyllomorphic sepal, not producing caeomasori but only spermogonia.

Fig. 11. Slightly phyllomorphic petal producing caeomasori only in one portion.

Fig. 12. Petal with the apical portion free from caeomasori and less deformed.

Fig. 13. Much enlarged petal undergoing different deformation in portions occupied and not occupied by the caeomasori.

Figs. 14–36. Variously phyllomorphic stamens.

Fig. 14. Anther-lobes expanded into four wing-like processes, and the basal portion of the filament undergoes a somewhat laminar deformation.

Fig. 15. The anther is replaced by double blades which are connected with the main blade derived from the filament by a narrow neck. *a*, under side; *b*, upper side.

Fig. 16. The entire stamen is represented by two blades, coherent, as it were, along their midribs.

Figs. 17, 18. The apex of the double blades bears a papilla-like process.

Figs. 19, 20. Lower portion of the filament becomes the main blade and an accessory blade derived from the anther-lobes rests on it with a short stalk.

Figs. 21, 22. The anther is replaced by a dichotomous leaflet, while the basal portion of the filament is mainly affected by phyllomorphic change.

Figs. 23–26. Lower half of the filament partakes of phyllody, while the upper half including the anther shows no essential change.

Figs. 27–29. Phyllomorphic change takes place independently in the upper and lower halves of the stamen.

Figs. 30, 31. Three-lobed staminal leaf.

Fig. 32. Peltate staminal leaf.

Fig. 33. Spatulate staminal leaf.

Fig. 34. Oblanceolate leaves representing entire stamens, coherent with each other along their petioles.

Figs. 35, 36. Dichotomous leaf representing an entire stamen.

Figs. 37–40. Petaloidal stamens in various degrees of change.

Figs. 41, 42. Shoot proliferated from the axil of a stamen.

Fig. 43. Healthy pistil shortly after fertilisation.

Fig. 44. Pistil of the partially affected flower shown in Fig. 2, with spermogonia on its surface.

Fig. 45. The same dissected, showing two ovules in the first stage of malformation. Above and below the ovules are seen serrated lobes along the suture line. ×2.

Fig. 46. Similar pistil, with the integument of the ovule unfolded into a slightly bifurcated lobe. ×2.

Fig. 47. Ovary of an affected pistil, opened longitudinally along the suture line. In the place of the nucellus appears a papilla-like process, resting on the laminar integument. *a*, outer view of the marginal portion of the carpel folded in the ovary; *b*, inner view of the same. ×2.

Fig. 48. Similar ovary opened. The ovules become marginal lobes. ×2.

Fig. 49. Young phyllomorphic carpel.

Fig. 50. The same with the margins spreading out laterally. Serrated lobes in place of the ovules are the largest. ×2½.

Fig. 51. Full grown phyllomorphic carpel. Ovules are not yet completely phyllomorphic and the nucelli are shown as papillae on an incompletely laminar integument. *a*, *b*, upper view of the ovules on the left and right side of the carpel respectively.

Fig. 52. Full grown phyllomorphic carpel provided with stipules and lobed margin. The largest lobe on either side occupies the position of the ovule.

Fig. 53. Gigantic phyllomorphic carpel from a flower, in which most of the floral organs have atrophied. A large irregularly parted lobe represents the malformed ovule.

Fig. 54. Trilobate carpellary leaf. Lateral lobe represents the malformed ovule.

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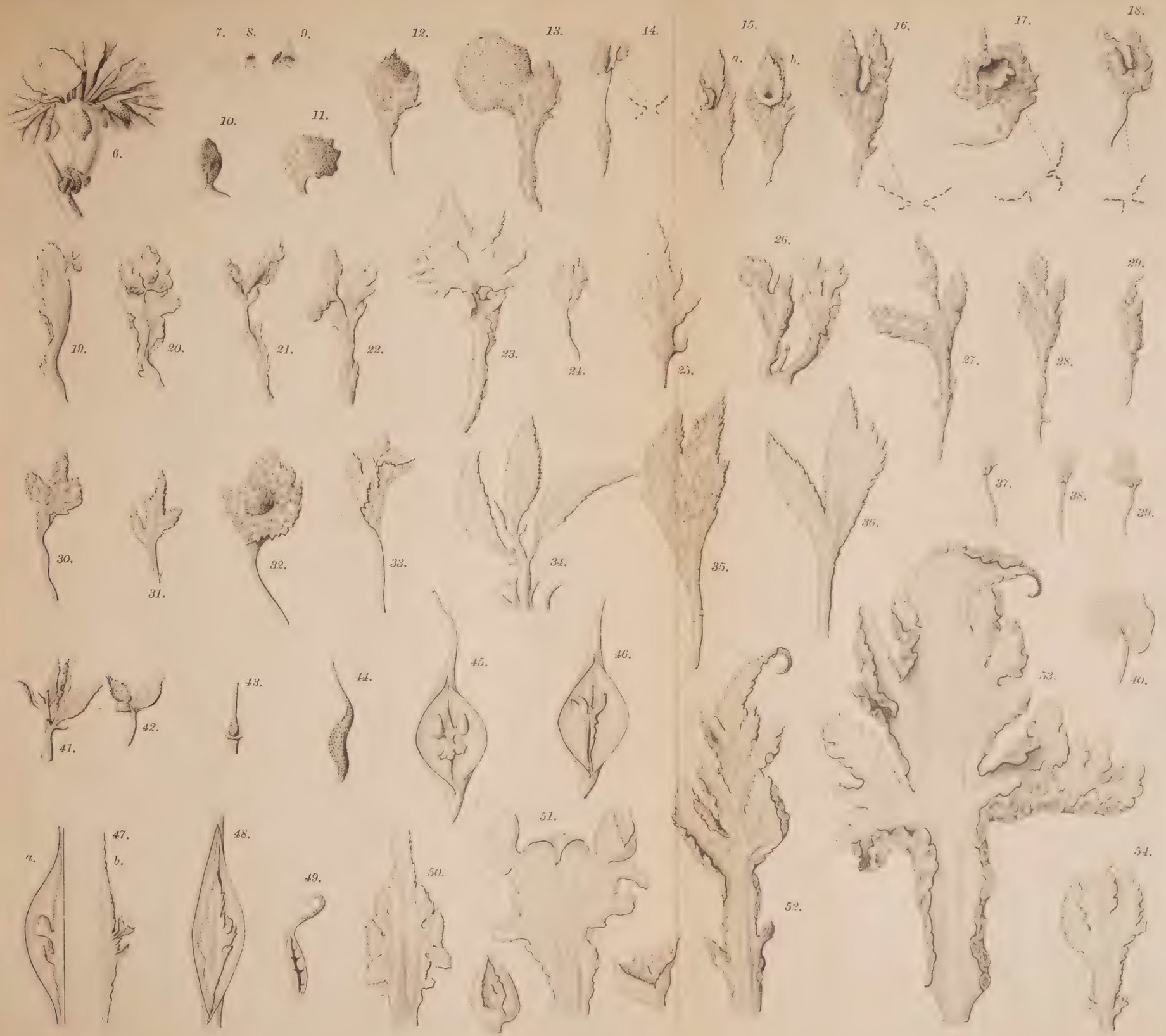

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Printed by H. Oye, Tokyo.

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Tokyo I 1907 No 2
p 163

Seed Infection by Smut Fungi of Cereals.

BY

S. HORI.

By what manner smut fungi gain access to their respective host plants has been carefully studied by Kühn, Wolf and especially by Brefeld, but some points regarding the modes of natural infection are not yet fully understood. The present knowledge concerning the modes of natural infection by various smuts of cereals may be summarized as follows:

1. *Soil infection:* smut spores which found their way into the ground, infest the young sprouts or seedlings of the host.

2. *Flower infection:* smut spores after being carried into the flowers of the host by wind, germinate and remain as mycoplasma in the inside of the seed.

3. *Wind infection:* certain smut spores or sporidia will develop not only in flowers but also on any young tissue of the plant to which they had been carried by wind.

4. *Seed infection:* Such kinds of smut spores which cannot be easily scattered by wind or rain, may become attached to the seed coat during thrashing.

In order to observe whether spores in the soil infest the host, I have tried many experiments during the last 5 years. The smut fungi, the spores of which were used for soil infection, were *Ustilago Tritici*, *U. Hordei*, *U. nuda*, *U. Sorghi*, *U. Reiliana*, *U. Crameri*, *U. Panici-miliacei*, *U. Maydis*, *Urocystis occulta* and *Tilletia laevis*. After thoroughly mixing these with the soil, seeds of the respective host plants were sown in different intervals partly on the same day, partly after 5 or 10 days. But the results were always negative and no difference with the control plants was noticed.

By these experiments it became clear that the spores in the soil do not infest the host plants, and if such a case should happen, it would be a very rare one, at least in Japan.

While I was writing this article, Brefeld's Brandpilze IV reached us in which he also reports negative results of 3 years experiments (1903–1905) in the infection of several substrata (fresh horse dung or barnyard manure mixed with soil) with the spores of wheat and barley smut. His most recent experiments show that his former opinion of an increase of the smut disease by the application of fresh horse dung is erroneous. This agrees also with my experience in Japan. It is true that the most Japanese farmers do not use fresh horse dung for wheat and barley. They use fish guano, human excreta, rice bran, and to some extent compost manure containing rice straw. Yet the damage by smut may often amount to a loss of 10–20%.

Wheat and barley are sown in Japan in October-November and harvested in the following May or June. It is a peculiar phenomenon that if the seeds are sown early in the season the smut proportionally increases and vic. versa; this fact has been experimentally proved already. In consequence, the smut is comparatively rare on wheat and barley cultivated in the rice field, because the labour of harvesting rice, draining, plowing and drilling delays the sowing at least 1 to 1½ months. That fact is undoubtedly due to the difference between the germinating temperature of the smut spore and that of the seeds. Though the seeds are sown late in November, yet they germinate, but for germination of the smut spores adhering to the seed coat or the development of smut germs in the seed, the soil temperature is already too low.

The fact that the occurence of the smut relatively decreases as the time of sowing becomes later and that there is no such tendency observed in summer wheat and barley, proves that the smut spores in the soil remain in an inactive condition.

Another very interesting fact, which clearly proves that the spores of smut fungi present in the soil are not the active source of the natural infection, was observed some years ago with the smut of Italian millet and sorghum in the field of our Experiment Station. The seeds of the last

mentioned plants were introduced directly from Manchuria in 1890 and in 1904, and were sown in the field of the Station. In the autumn of the respective year, about 50% of Italian millet and 10% of sorghum were smutted. Since the smut of Italian millet (*Ustilago Crameri*) is in Japan very rare and only known in a limited area in the province of Shinano, and since the smut of sorghum (*U. Sorghi*) is still rarer and as I had not yet observed the smut on Japanese sorghum, I concluded that the spores of these smut fungi must have been introduced with the seeds of the respective host plants.

The second problem relates to the question whether the spores brought inside of the flowers may be infective or not. Mr. S. Nakagawa[1] of our former Branch Station at Matsuto (near Kanazawa city, the Prov. of Kaga) carried out an Experiment on this point early in 1897. He introduced the matured spores of *U. Tritici* into the flowers of wheat in the same field by means of a forceps. The infected seeds were sown in the ordinary time of the autumn of the same year. In the following year the ears, as soon as they appeared, were found to be all smutted. Similar experiments made by Mr. K. Yamada gave the same result.[2] Soon afterwards I obtained similar results in flower infection with *U. Tritici* and *U. nuda*. Hence I concluded that the spores of those smuts which mature at the flowering time of the host and may be scattered easily by the wind, will be retained in the innerside of the seed and give rise to the smut disease during the next flowering time of the host plant.[2]

Moreover, the above conclusion was also proved afterwards by Brefeld[3] and Hecke.[4] The latter author has clearly shown microscopically the presence of smut germs in the form of mycoplasma in the tissue of the embryo of the seed which matured after artificial flower infection. Hence, it is now clear that at least *Ustilago Tritici*, *Us. nuda* and *Us. Hordei* may naturally infest the respective host plants by the flower infection.

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1). Bull. Agr. Expert. St. Nishigahara, Vol. XII, No. 4, 1898. (Japanese.)

2). Rep. Local Agr. Soc. Kioto, 1896. (Japanese.)

3). Farmers Bull. Agr. Ex. St. Nishigahara, No. 11, 1900. S. Hori, Diseases of Agr. Plants, 1901. (Japanese.)

4). Untersuch, a. d. Gesammt. d. Myk. XIII, 1905.

5). Zur Theorie d. Blüteninfection des Getreides durch Flugbrand. (Berichte d. deutsch. Bot. Gesell. XXIII. Heft 6, s. 248. Taf. VIII, 1905.)

In regard to wind infection, Brefeld[1] was the first who proved it experimentally with Indian corn smut. Since the latter smut may occur on any part above ground of the host, the character is quite different from that of the other smuts of cereals. He sprayed the sporidia of the smut on the young inflorescence, leaves, growing point and air roots of the host and succeeded to produce the smut blisters on any intended part. The Indian corn smut (*Ustilago Maidis*) can therefore infest any part of the host by wind, the only example among the numerous smuts of cereals.

In regard to the fourth question, whether the spores of smut fungi attached to the seed coat of the host plants are infective or not, I have tried many experiments, some of which have not yet been finished. The smut fungi used for seed infection were *U. Tritici*, *U. nuda*, *U. Hordei*, *U. Reiliana*, *U. Crameri*, *U. Panici-miliacci*, *Tilletia laevis*, and *Urocystis occulta*.

All the seeds used in the experiments were disinfected by the hot water treatment[2] before the spore infection was carried out. That this hot water treatment prevents thoroughly the smuts above enumerated has been experimentally proved here already. The disinfected seeds, after being a little moistened with distilled water, were thoroughly mixed with the smut spores until the surface became brownish, and were directly sown in the usual manner at the proper season.

In spite of numerous trials, the seed infections with the spores of *U. Tritici*, *U. nuda*, *U. Hordei* and *U. Reiliana* yielded always negative results, while on the contrary the experiments with the spores of the following smut fungi always yielded positive results. The details will be described below.

I. Infection of Italian millet (*Setaria italica var. germanica*) with *Ustilago Crameri*.

A. Experiment in 1896.[3]

On account of the absence of smut on the Italian millet in the vicinity

1). Untersuch. a. d. Gesammt. d. Mykologie, XI, 1895.

2). The seeds after being soaked for 7 hours in cold water were kept some minutes in water of 50°C and then immersed for 5 minutes in water of 55°C.

3). Bull. Expert. Station, Nishigahara, Vol. XI, No. I. (In Japanese.)

of Tokio, seed (var. *Wase*) from a field, in the Prov. of Nagano about 100 miles north west from Tokio, where the smut had caused much injury in the previous year, were used for the experiment.

Before sowing the seed, the latter was tested by the following method to see whether smut spores were attached to the seed coat or not. Ten grains were thoroughly washed with distilled water which was then evaporated. Thirty-eight spores were thus observed under the microscope. This proved clearly that the smut spores became attached to the seed coat by careless thrashing in the presence of smutted ears.

On July 2 this seed was sown in a plot of 108 square feet and at the same time a variety of *Akita* raised on our Station field also was sown in a check plot. At the harvesting time, September 25, 144 ears of *Wase* were observed smutted, while no smut at all was on *Akita*.

B. Experiment in 1897.[1)]

The smutted ears collected in the plot of the infection experiment carried on the previous year and preserved in a paper pocket, were gently ground in a mortar to break up the spore masses and the latter were then mixed with moistened seeds of *Wase* and *Akita* millet. These seeds were sown July 10 and the plants harvested October 1. The result was as follows :

Variety.	Remarks.	Area of a plot.	No. of the healthy ears.	No. of the smutted ears.	Percentage of the smutted ears.
Wase 1	mixed with the smut spores	216 sq. ft.	247	1234	83.3
„ 2	„	324 „	386	1851	82.7
Akita	„	„	116	459	87.4
Wase	check	„	1394	80	5.4
Akita	„	„	758	0	0

1). Bull. Expt. St. Nishigahara, Vol. XIII, No. I. (In Japanese.)

C. Experiment in 1898.[1]

The experiment carried on the previous year was repeated with the seeds of Wase and Akita millet. The seeds were sown July 5 and the plants harvested September 21. The result was as follows:

Variety.	Remarks.	Area of a plot.	Sound ears.	Smutted ears.	Percentage of the smutted ears.
Wase	mixed with the smut spores	108	374	324	46.4
Akita	„	„	304	266	46.6
Wase	check	„	311	9	2.8
Akita	„	„	386	12	3.0

In this year the smut not only appeared to a small extent on the check plot of both *Wase* and *Akita* millet, but it was found also on some other varieties of millet in the experiment field (20 varieties were cultivated) on which the smut had not been observed before. But it was soon discovered that this unexpected result was due to negligence since the mats and implements which had been used for harvesting and thrashing the infected millet of the year before, had been used without previous disinfection.

For determing exactly the percentage of the smutted ears produced by the spore infection in the plot, the thinning process was not carried out. On this account, the growth of the millet plants was very irregular, most of which beared no seeds. Moreover, the smut being concealed entirely in the inside of the seed coat for a long time, it requires the greatest care and experience to recognize smutted ears especially when unripe. This difficulty was the cause of the smutted ears being thrashed together with sound ones.

Conclusion: By the results obtained during the last 4 years it was therefore decidedly proven that the smut of Italian millet is produced by

1). Bull. Expt. Station, Vol. XV, No. 1, Nishigahara, 1899 (Japanese).

the spores adhering to the seed coat, where they have been carried by uncautious treatment in harvesting and thrashing or to some extent by the wind while the plants are standing in the field.

II. Infection of wheat with *Tilleti laevis*.

A. Experiment in 1898.[1)]

Bunt or Stinking smut of wheat caused by *Tilletia Tritici* or *T. laevis* is entirely absent in the vicinity of Tokio, but it may occur to a small extent in some localities of Japan. The smut for my infection experiments was obtained 2 years ago (Feb. 1896) from a grower in the Prov. of Shinano and was preserved in the herbarium in a paper pocket. The smutted grains were carefully ground in a mortar to break up the spore masses and the spores were then mixed with moistened seeds of wheat (d'Australie). These seeds were sown October 31 and the plants harvested June 9 in the following year. The result was as follows:

Remarks.	No. of seeds sown.	Area of a plot.	No. of smutted ears.
Seeds mixed with spores ...	3000	324 sq. ft.	430
Check	„	„ „	3

Further the number of diseased plants was examined in order to show how many seeds are infected and how many ears were produced from the infected seeds. The result was as follows:

No. of seed sown mixed with the spores.	No. of actually infested seeds.	Percentage of infected seeds.	No. of ears produced from infected 164 grains.	
			Smutted.	Sound.
3000	164	5.46	430	58

1). Bull. Expt. St. Nishigahara 1901, No. XVIII (Japanese).

B. Experiment in 1904.

The smutted grains for these experiments were obtained from the Breeding Farm in the Prov. of Shimosa belonging to the Imperial Court. The original seeds (*Ishima*) came from the Prov. of Idzumo in 1903, which had suifered great damages by the smut. Repeated experiments showed that the most spores of the smut had lost their germinating power. The wheat grains raised in our Station field were nevertheless mixed with these spores and sown Nov. 1. The wheat was harvested June 15, 1905 with the following result:

Remarks.	Area of a plot.	Number of smutted ear.
Seeds mixed with spores	324 sq. ft.	92
Check	„ „	0

The comparatively small number of the smutted ears clearly shows that the smut spores for the most part had lost their infective power owing to an uncautious preservation of the sample. But nevertheless the result agrees as a whole with that of the previous experiments.

C. Experiment in 1905.

The smutted grains produced in the plot of the previous infection experiment and preserved in a paper pocket, were carefully ground and mixed with moistened wheat grains (*Fultz*). These seeds were sown October 27, 1905 and the plants harvested June 8, 1906. The result was as follows:

Remarks.	Area of a plot.	Number of smutted ear.
Seeds mixed with spores	324 sq. ft.	827
Check	„ „	0

From the results obtained in the last 3 years we may conclude the following:

1. Stinking smut of wheat is produced by the spores adhering to the seed coats. Uncautious thrashing is the only possible way by which the spores reach these spots.

2. Three years old spores still possess infective power.

3. Infected grain produces mostly smutted ears, but often healthy ears are also found among them.

III. Infection of Wheat with *Urocystis occulta*, *Rabenh.*

A. Experiment in 1898.[1]

The smut produced by the attack of *Urocystis occulta* being most abundant on rye is commonly known as rye smut or Roggenstengelbrand, but this smut also occurs occasionally on oats and barley in Europe and has been found according to Wolf on wheat in Australia. In Japan I first observed this smut on wheat in the vicinity of Oita in Kiushu in 1895. Since then it has also been found in several other localities on wheat, but not yet on barley, oats or rye. The latter two kinds of cereals, however, are seldom cultivated in Japan. The most noticeable outbreak of this smut on wheat was observed in 1898 in a field in the Prov. of Kai where all plants of an area of about ¼ of an acre were entirely destroyed before flowering time. But such great damage to wheat is thus far an exceptional case.

The smut spores for my infection experiments were obtained from the smutted wheat just mentioned, by slightly shaking the plants. The spores were then mixed with the moistened grains (d' Australie) which were sown October 30. The plants were harvested June 6 in the following year. The result was as follows :

Remarks.	Number of seeds sown.	Number of smutted plants.
Seeds mixed with the spores.	3000	1347
Check	„	0

1). Bull. Nishigahara Expt. St. No. XVIII, 1901 (Japanese).

Furthur it was noted how many plants were smutted, showing the number of the actually infested seeds. The result was as follows :

No. of seed sown.	No. of seeds produced the smutted plants.	No. of plants produced from the actually infested seeds.	
		Smutted.	Healthy.
3000	440	1347	1042

B. Experiment in 1899.

The smutted plants produced in the plot of the previous infection experiment and preserved in a paper pocket, served in the same way for the following experiment. The infected seeds were sown October 31 and the plants harvested June 30 in the following year with the following result :

Remarks.	Number of seeds sown.	Number of smutted plants.
Seeds mixed with the spores	3000	1534
Check	„	0

How many seeds sown produced smutted plants is seen from the following table :

No. of seeds sown.	No. of seeds produced the smutted plants.	No. of plants produced from the actually infested seeds.	
		Smutted.	Healthy.
3000	504	1534	1256

Conclusion : These two years experiments decidedly prove that the smut is produced by the spores of *Urocystis occulta* adhering to the seed coat whither they have been carried by careless thrashing. But it may be possible to some extent, that the matured spores, being easily scattered by winds, could also reach the innerside of the flowers and thus may be kept until thrashing time.

Infected grains produced both smutted and healthy plants nearly in the ratio of 3 : 2 without reducing the power of off-shooting.

IV. Infection of Millet (*Panicum Miliaceum*) with *Ustilago Panici-miliacei* (*Pers.*) *Winter*.

A. Experiment in 1899.[1]

In August 1898, a farmer in the Prov. of Tokachi, Hokkaido sent to our Station some specimens of millet smut which year after year had caused great damage leading sometimes to the entire loss of a harvest, and asked for a proper method of prevention. Until then millet smut had never been reported, though millet is commonly cultivated throughout Japan. But according to recent researches, it becomes clear that millet smut is restricted to Hokkaido and to some localities of Mutsu, the northernmost province of Hondo (Main island) of Japan. The specimens received astonished us, and led us to a series of experiments in 1899.

The smutted panicles were carefully ground and then mixed with the millet seeds raised in our Station field. The seeds were sown July 10 and the plants harvested August 23. The result was:

Remarks.	Area of a plot.	No. of smutted plants.
Seeds mixed with spores	288 sq. ft.	567
Check	„ „	0

The appearance of smutted panicles closely resemble that of Sorghum smut (*U. Reiliana*), but the difference is that the smutted panicles covering the shinning white membrane, are concealed for a longer time between the green leaves and that the infested plants remain of a greenish color, while the healthy plants become yellowish in ripening. When the main panicle was smutted, the secondary panicles, beginning to grow from the lower leaf-axis, were all found smutted too.

1). Bull. Nishigahara Expt. St. No. XVIII, p. 10, 1901 (Japanese).

B. Experiment in 1900.

Smutted panicles from the previous infection experiment, served now for the next experiment. The seeds were sown July 6 and the plants harvested August 20. The result was :

Remarks.	Area of a plot.	No. of smutted panicles.
Seeds mixed with spores	360 sq. ft.	791
Check	,, ,,	0

C. Experiment in 1906.

The smut spores for the experiment were two years old and obtained from Hokkaido Experiment Station. Two grams of these spores were mixed with 45 grams of millet seeds which were then sown July 10. The plants yielded, on being harvested September 27, the following result :

Remarks.	Area of a plot.	No. of ears.	
		Smutted	Healthy
Seed mixed with spores	468 sq. ft.	3135	3160
Check	,, ,,	0	not counted

Conclusion : By these three years experiments it becomes evident that the millet smut is produced by the spores of *Ustilago Panici-miliacei* adhering to the seed coat whither they have been carried by careless thrashing. This was clearly proved also by the following facts. The millet in central and southern Hondo is commonly harvested by cutting the ripened, healthy panicles only, so that there is no occasion for the smut spore adhering to the seed coat in thrashing. In Hokkaido, however, the entire millet plants are cut near the ground regardless of disease and then thrashed ; thus the smut spores of the smutted panicles, can adhere to the seed coat. Hence the real cause of millet smut being restricted to Hokkaido is clear.

In 1902, Mr. Y. Takahashi[1] of the Hokkaido Agricultural Experiment Station in Sapporo, carried out also such infection experiments with the millet seeds and smutted panicles also obtained from the Prov. of Tokachi. The result of his experiment was :

Remarks.	Area of a plot.	No. of smutted plants.
Tokachi millet seeds	360 sq. ft.	465
Same seeds mixed with spores	,, ,,	Almost all the plants were smutted.

This result essentially agrees with mine.

In addition, a few words may be permitted as regards the infection experiments with millet smut by Brefeld.[2] His method does not decide the present question whether the smut spores adhering to the seed coat are infective or not. He sprayed the germinated spores on very young millet seedlings and for securing the inoculation the latter were kept one week under a cover, and then transplanted to the field. By this method he obtained 60–70% of smutted plants.

Summary.

Soil infection, although known in other cases, does not generally take place by the smuts of cereals ; such a case would constitute surely a very rare exception, at least in Japan.

The smuts of cereals may be classified as follows according to their respective mode of natural infection :

Ustilago	Tritici.	Flower infection.
,,	Hordei.	,,
,,	nuda.	,,
,,	Maidis.	Wind infection.
,,	Panici-miliacei	Seed infection.
,,	Crameri.	,,
,,	Reiliana.	,, ?
,,	Sorghi.	,, ?

1). Bull. Hokkaido Agr. Expt. St. No. I, p. 112, 1902 (Japanese).
2). Untersuch. a. d. Gesammt. d. Myk. Heft XIII. p. 59. 1905.

Ustilago Avenae.	Seed infection.	?
„ laevis.	„	?
Urocystis occulta.	„	
Tilletia laevis	„	
„ Tritici.	„	? *

* The interrogation mark signifies that the experiments with the particular smuts are not yet finished.

Smut on Cultivated Large Bamboo (Phyllostachys).

BY

S. Hori.

Introduction

In 1894, Mr. Y. Tanaka sent to me from the province of Mino some specimen of smutted branches of Hachiku-bamboo (Phyllostachys puberula *Munro*) inquiring after the nature of the disease and its prevention. As far as I know, the smut on bamboo has heretofore been not reported, neither in Japan nor elsewhere, and the specimen mentioned had been kept since in the herbarium of our Station bearing the unpublished herbarium name "Cintractia Bambusae *Miyabe et Hori*" as other work prevented me to investigate the matter. Since that time I received annually further specimens of branches attacked by the same disease not only on Hachiku-bamboo, but also on Madake-bamboo (Phyllostachys bambusoides *Sieb. et Zucc.*) from many of my friends and bamboo-growers from several provinces of Japan. I, myself had also occasion to observe the disease in several localities, especially in the warmer region of Japan.

The smut of bamboo is known by the local name of "Susu" (soot) among the bamboo-growers in the prov. Harima. It is also known by the name of "Jinengo" (wild rice) in the prov. Mino, as it resembles somewhat to the fructifying branches of bamboo, called also wild rice. This serious disease leads to the death of the entire bamboo forest. It is reported that the flowering of bamboo takes place after 60 years of existence and this is mentioned also in several Chinese and Japanese books of natural history and in monographs on bamboo; but we found nowhere an account about the smut

In 1900, Prof. Dr. P. Hennings* of Berlin described a smut on a

* P. Hennings, Fungi japonici I. Engler's Bot. Jahrbüch. 28 Bd. 3 Heft. 1900. p. 260.

Japanese wild low bamboo (Sasa ramosa *Makino et Shibata*) collected by Prof. Dr. M. Shirai in Nikko, and he gave the scientific name Ustilago Shiraiana as a new species ; the descriptions is as follows :

Soris in ramis junioribus, eos deformantibus et incurvantibus, primo epidermide pallida tectis, dein pulverulentis, atro-olivaceis ; sporis subglobosis v. ellipsoides, pallide olivaceis v. fuscis, levibus, $4-7 \times 3\frac{1}{2}-6\ \mu$.

Hab. in ramis junioribus Bamboo Veitchii, Nikko Japoniae (Shirai)

By comparing the description of U. Shiraiana *Henn.* and the specimen C Bambusae *Miyabe et Hori*, they do not agree in regard to the shape and size of spores and in some other characters.

In the beginning of the last year, Dr. G. Yamada, professor of the Morioka Higher Agricultural and Dendrogical School, kindly sent to me a good specimen of smut on wild low bamboo (Sasa paniculata *Makino et Shibata*) which bears the name of U. Shiraiana ; and at almost the same time I received this same smut collected in the prov. Mutsu by Mr. N. Nambu. In May when I was travelling in the mountainous region of the prov. Kai, I also found fortunately the same smut on wild low bamboo (Arundinaria Simoni *Riv.* var. Chino *Makino et Shibata.*)

By comparing these three samples of smut and that on the cultivated large bamboo, it became clear that these smut fungi are quite similar, but they do not agree in the descriptions with U. Shiraiana on the points already mentioned.

Hence I consulted Prof. Dr. M. Shirai of the Agricultural College in the Imperial Tokyo University to get his original specimen of U. Shiraiana for deciding the question of what kind of Japanese bamboo smut Prof. P. Hennings described as U. Shiraiana.

By comparing the smut fungi of the various kinds of bamboo at present in my hand, it appears that they are all identical, while at the same time, it became clear that in Hennings descriptions of U. Shiraiana there are some defects which undoubtedly are due to his observations on some old and dry specimens.

In Japan the several kinds of bamboo, both cultivated and wild, are of large ecomomic use ; hence the study of bamboo smut is of great importance.

The following contains the results of identification of smut fungi on cultivated large bamboo and U. Shiraiana together with the germination of spores.

Symptoms of the Disease.

The disease always occurs on the younger internodes and growing points of branches, and it appears also that the disease may occur whenever the surrounding conditions be favorable from the time when the spring buds burst until the growth of the branches ceases. According to the degree of development of the branches when attacked, the symptoms of the disease are divided into two categories in which the extent of damage may naturally differ.

When the young short branches still covered by the leaf-sheathes and bracts, that is the elongated buds, be attacked, they assume at first a somewhat swollen and stouter form, and since no particular deformations or appearances externally are noticeable common observers will suspect no disease. (Pl. IX. fig. 1, Pl XI fig 1.)

Such diseased branches seem generally to stop their further growth, while the smut fungus is continuing the spore formation. Finally the leaf-sheathes and bracts, the external coverings of the buds, begin to open and die off, and the smutted internodes and growing points covered with brownish powder of smut spores make their appearance from inside. (Pl. IX, X, XI. fig. 2.).

The smut is restricted to the internodes and growing points of young branches, and often on the lower part of the young leaf-sheath. By the slight prolongation of the infested internodes, the growing points and uppermost part of internodes are pushed upwards, while the latter are still covered closely by the bracts and leaf-sheaths. The affected parts become wrinkled or bent to one side showing numerous lateral folds.

When most of the young branches are affected by the smut, the winter buds or undeveloped spring buds soon after begin to develop. In a certain stage of development, the numerous diseased and healthy branches crowded on certain spots of the old branches give the impression of hexenbesen

Since this formation somewhat resembles flowered branches, it is mistaken by the growers as a sign of the "Jinengo-disease" (Pl. X. fig. 1).

The symptoms thus far mentioned are commonly observed on the young branches not more than 3 or 4 centimeters in length, which is the case in the latter part of May or the beginning of June, according to the temperature of the localities and the rain fall.

As far as my observations go, the second new branches are commonly free from the smut, but they might possibly be affected by the disease also, if the surrounding conditions would be favorable, because the disease may occur late in July or even in August on the upper part of branches of considerable length; about the latter form of smut I will explain hereafter

While short branches show the infection all over, the long branches show it only on the growing points and upper internodes, since their lower internodes have hardened; branches of 15—18 cm. length show this condition frequently, the lower 10—12 cm. being entirely free from smut (Pl. XI. fig. 3)

Such cases are commonly met with in July or August. The smut on wild low bamboo in most cases has the symptoms just mentioned (Pl. XI. fig. $\frac{2}{3}$)

The deformations of the upper portion of the long branches resemble those of the young smutted branches. (The winter buds on unaffected internodes of branches smutted on the upper part are often accelerated in their development.)

Commonly the smut spreads over all of the branches of a single stock of bamboo and cases are not rare that a large forest is entirely infested. Sometimes, however, it is restricted to certain branches only and in some cases I observed, that the smut is restricted to the bamboo growing on the outskirts of a forest. When once the smut has invaded a forest, the disease will show more or less annually though the degree differs according to the weather

Conditions Favorable for the Disease.

It is reasonable to suppose that the smut on bamboo had been present

more or less somewhere in Japan already at some remote time, though we can not find any record It may also be possible that the smut formerly has been too rare to arouse the attention of the bamboo-growers until about ten years ago.

As a matter of fact the demand for bamboo is gradually increasing year after year for the manufactures of house utensils and other objects, for building materials of houses and fences, and it is also largely used for the protection of river banks. This increased demand for bamboo has induced the culture of bamboo forest everywhere and the growers pay now much more attention to their bamboo forests than formerly, which is also the reason why the occurrence of the smut is reported by many growers Secondly, the increase of bamboo forests facilitates again the spreading of the smut fungi.

According to the symptoms of the disease, the occurrence of smut has a close relation to the rain fall and wind at the time of the development of the attacked branches. The restriction of smut to the upper part of the longer branches shows really such a relation.

Though my observations were limited to some localities, the following facts may also prove this. In 1902, the rain fall had continued about three weeks between May and June; so that I had postponed my departure until the 5th of June. During this journey lasting four weeks in the prov. Omi, Bizen, Aki and Sanuki, I have met with severely smutted bamboo forests everywhere.

The wind is a principal factor of transporting the spores for the propagation of and natural infection by the smut. Since the branches of bamboo growing on the outside of the forest are much more smutted than the inner, a relation to the wind becomes evident.

The relations to manuring and to the influence of the moisture of the soil are not yet clear. The bamboo growing on unmanured dry sandy banks of rivers or on hill-sides are just as well attacked, as that growing on fertile soil.

Damages and Distribution.

When most of the young branches are severely attacked by the smut,

the growth of the bamboo stocks is greatly disturbed and death results. The affected stems became brittle whereby the value is greatly reduced, or the stems may even become entirely useless for certain purposes. The smut disease of bamboo causes therefore great damage to the growers who are as much afraid of this dreadful plague as of the flowering of the bamboo, which also causes the death of the plants.

But when the upper elongated branches alone are attacked the effect on the further life of the bamboo is not directly perceivable.

The smut has been found on several kinds of bamboo, both cultivated and wild, throughout the empire. In the warmer regions where the large bamboo (Phyllostachys) is widely cultivated, the smut is found only on cultivated bamboo, and was not yet found on wild bamboo; while in the northern cold climate, the smut occurs merely on wild low bamboo.

At present, the smut is known to occur on the following four species of bamboo, namely, Phyllostachys bambusoides *Sieb. et Zucc.*, P. puberula *Munro*, Sasa ramosa *Makino et Shibata* and Arundinaria Simoni *Riv.* var. Chino *Makino et Shibata*; the former two species are cultivated and thrive well in the warmer region, while the latter two species are entirely wild low bamboo, growing on road side or hills in the northern regions.

It is peculiar that the smut is not yet found on Moso bamboo (Phyllostachys mitis *Riv.*) though the allied species of Hachiku and Madake-bamboo are largely cultivated side by side with the latter.

I fear the smut would some day in future be found also on the Moso bamboo and also on numerous other wild species.

Smut Fungi.

The smut fungus after penetrating into the tissues of the growing points, internodes and also the lower part of leaf-sheath of the young branches, begins to form the spores on their surface; by the gradual increase in number and the maturation of the spores, the leaf-sheath and bracts which still cover closely the outer part of the affected branches are pushed out and in opening widely the deep brownish spore-masses are brought to light.

In scraping off the leaf-sheath and bracts of the affected branches in the earlier stage in which practically no external particular appearance of disease is noticed, we can perceive the faintly brown colored surface, with here and there some small brown spots, of the growing points and internodes These brown spots are the portions where the spores matured a little earlier than on others.

A cross section of the affected internodes under the microscope shows the presence of mycelium running throughout the tissue, and on the surface of the internodes the spores of different size and color are seen in chain-like arrangement. It is of special importance to notice that the ruptured epidermis of the host in the smutted part is not perceivable, though Prof. Dr. P. Hennings wrote "Primo epidermide pallide tectis" in his description.

Indeed, the epidermis of the host when infested by the smut fungus is very young and not yet fully differentiated. Hennings so called overlapping epidermis are no doubt, the dead leaf-sheath and bracts and not the true epidermis of the host.

The matured spore-masses are deep brown in color and light and pulverulent in texture. The spores are easily blown away by the wind or washed down by the rain, after the coverings of the bracts are opened.

Under the microscope the spores appear mostly spherical, sometimes subglobose or elliptical, and they are almost uniform in the shape in different specimens; light olivaceous or sometimes light brown in color; contents finely granular with often one or two oil globules at the center; epispore rather thin and smooth, $5.5-11=5.5-12\ \mu$ large, but $6-9=6-10\ \mu$ is the most common size.

About the shape and size of spores, my observation differs somewhat from that of Prof. P. Hennings. But this contradiction was fully solved after my observation on the Hennings original specimen, which Prof. M. Shirai kindly sent to me for comparison, and the fresh specimen of the same smut fungus on the same host. It has become clear that Hennings has observed

the smut of a comparatively old dry specimen in which the spores were mostly shrunk and reduced in size.

In fresh or comparatively recent specimen, the spores are mostly spherical and those of subglobose or elliptical form as Hennings described, are rather rare. The spores commonly attain the size of about 6—9=6—10 μ; hence they are much larger than those described by Hennings, while in general the smut spores on Phyllostachys are comparatively larger than that on Sasa and Arundinaria. The latter fact is a common phenomenon on the numerous other parasitic fungi and it is of no value for separating the species on the systematic standpoint, because the other characters viz. shape, color, germination etc. are quite similar.

The following is the measurement of the size of the spores taken at random from the different specimen and the host.

Specimen.	Size of the spores in μ.		
On Arundinaria Shimoni *Kiy.* var. Chino *Mak. et Shib.*, Prov. Yamanashi, (S. Hori).	7×7	6×6	6×6
	7×7	8×9	7×9
	7×7	6×8	8×8
	8×8	7×7	6×7
	6×6	7×8	6×6
	7×8	8×8	7×7
	8×10	8×8	6×6
	6×6	8×8	8×8
	7×8	6×6	7×8
	6×7	6×7	8×8
	8×8	7×8	6×7
	6×6	8×8	6×7
	7×7	6×6	8×9

Specimen.	Size of the spores in μ.		
On Sasa ramosa *Mak. et Shib.*, Prov. Aomori (N. Nambu).	6×7	7×8	8×8
	7×7	7×8	7×7
	7×7	6×6	6×6
	8×8	8×8	8×8
	7×7	7×7	6×7
	7×8	8×8	7×8
	6×6	6×7	7×7
	6×6	7×7	6×6
	5·5×6	7×8	8×8
	6×6	8×8	8×8
	7×7	6×6	9×9
	7×8	7×7	6×6
	7×7	8×8	6×6
On Sasa ramosa, Prov. Morioka (G. Yamada).	7×8	6×6	7×7
	8×8	6×6	6×8
	6×7	6×6	6×6
	7×7	8×8	5·5×7
	6×6	5·5×5·5	7×7
	7×8	8×8	8×8
	7×8	7×8	7×8
	6×8	8×8	6×7
	6×6	8×9	6×8
	8×8	6×6	7×8
	8×8	6×6	8×8
	7×8	8×8	6×6

Specimen.	Size of the spores in μ.		
On Phyllostachys puberula *Munro*, Prov. Mino, (Y. Tanaka).	8×8	9×9	9×9
	9×9	8×8	7×8
	7×8	9×9	8×8
	7×8	9×9	8×8
	8×8	9×9	9×9
	8×8.5	7×8	7×8
	9×9	7×8	8×9
Yamato specimen (B. Nakano).	8×10	10×10	10×10
	6×7	10×10	9×10
	9×9	8×9	9×10
	10×10	8×10	8×8
	8×8	9×9	8×9
	10×10	7×8	9×9
	7×8	7×8	10×10
	8×9	9×9	10×10
Tokio specimen (T. Makino).	8×9	8×8	6×9
	7×7	8×9	7×8
	7×7	9×9	8×8
	8×8	8×8	8×8
	8×8	8×8	8×9
	6×7	6×7	8×8
	8×8	6×7	7×8
Tokio specimen (S. Hori).	8×10	10×10	8×9
	8×8	10×10	9×9
	9×9	9×10	9×10
	7×10	9×9	8×8
	8×8	9×11	10×10
	10×10	9×9	8×8
	8×9	8×8	8×9

Specimen.	Size of the spores in μ.		
Yamato specimen,* (T. Jinno).	11×11	9×9	10×10
	10×11	10×10	10×10
	8×10	8×9	10×10
	10×10	8×8	10×10
	10×10	8×9	10×11
	10×10	10×10	10×12
	10×10	10×10	8×9
On Ph. bambusoides *Sieb et Zucc.*, Prov. Harima, (K. Watanabe).	8×8	9×9	8×8
	8×9	9×9	6×7
	6×7	9×9	9×9
	8×8	7×8	9×9
	10×10	7×7	8×9
	7×7	10×10	7×7
	8×8	7×7	6×7
	7×8	9×10	8×9
Kaga specimen (R. Taniguchi).	8×9	9×9	8×8
	8×9	7×8	8×8
	8×9	9×9	8×8
	8×9	8×8	8×9
	7×8	8×8	8×9
	8×8	9×9	8×9
	7×8	8×10	9×9
	8×9	8×8	9×10

Germination of Spores.

Before entering into the details of the germination of the spores, it is important to notice the methods of culture carried on. The materials were always chosen from the fresh specimen, and the spores for germination were

* In this specimen spores are much larger and pale olivaceous in color.

taken by means of a sterilized platinum needle from the smutted portion of bamboo branches, where the spore-masses were still covered by the leaf-sheath, in order to avoid the admixture of foreign impurities. By this precaution, I have succeeded in most cases in the culture of the spores in an almost pure condition.

For the germination of the spores, I have used the hanging drop culture with the Van Tieghem cell of ½ cm. high and 1½ cm. of inner diameter, and the slide of the hollow place at the center. The cells and slides were sterilized previously and the former was fastened to the latter by vaseline.

The sterilized distilled water used for the germination of the spores was dropped on the surface of the sterilized cover glass by means of a platinum needle, and after the spores were sown into the water, the cover glass was kept inverted over the cell to which it was fastened with vaseline. But in most cases the spores were not sown directly into the water, they were first sown thinly on the dry surface of a cover glass, and the latter was then inverted over the cell into which a few drops of water previously were poured. After a few hours some vapour condenses on the spores of the cover glass, and thus almost the same condition was reached as in directly sowing the spores into the water. Indeed, for the continued observation on the growth of certain spores, the latter method is of much more convenience.

As a culture medium a ~~20~~ 10 % solution of the Japanese ame* was principally used. The bouillion sometimes used was prepared after the formula ordinarily followed by bacteriologists; but it accelerated the growth of bacteria and greatly retarded the germination of the smut spores. Aside from this defect there was no apparent advantage compared with the ame solution. The modified Cohn solution was also used, but the result was practically the same as with the ame-solution.

Throughout the work the greatest care was taken to preserve the cultures free from contamination of any sort. Unless otherwise stated, the cultures were kept in a light-proof thermostat at a temperature of 25°±C.

Germination in water: the fresh spores germinate readily within 10 hours, a spindle shaped promycelium protruding, which when attaining the

* Ame is a transparent semi-fluid of sweet taste made from malt and rice or millet.

full growth, becomes a single septated long spindle or cylindrical form 3½ μ in breadth and 20—22 μ in length with numerous vacuoles, and the lower younger portion of the promycelium forms what Brefeld calls a knee to which the upper portion of the promycelium is attached. Rarely the secondary promycelium is protruding from one side of the knee; it finally attains the same form as the primary promycelium.

The detached promycelium produces one or two sporidia at the septum or the end, which may be detached or not and will develop to the same form as the primary promycelium; but in the most cases, the sporidia are developed into the slender long hypha.

Germination in a nutrient solution: almost the entire number of the spores sown have germinated within a few hours and each produces a long spindle or cylindrical promycelium which apparently does not differ in shape from that formed in water. But the germination of spores in a nutrient solution compared with water, is far more vigorous and luxuriant, and the full grown promycelium attains 3—5 μ in width and 20—36 μ in length, commonly 4 and 28 μ.

In 20—24 hours, while the primary promycelium still is attached to the knee, the secondary promycelium begins to make its growth from the knee, and in the next 24 hours both, the primary and the secondary promycelium, are septated by one or two cross partitions, and often a third promycelium is produced. The full grown promycelium is easily detached and produces sporidia on the apex or near the septum. Often two continuous segments of a detached promycelium may become united by the knee-joint fusion which finally produces one sporidium after developing to some length.

When the detached promycelium is removed into a fresh nutrient solution, it makes a more vigorous growth, increasing in length and breadth, and forming many septa. In this case mostly 3 sporidia are produced directly at the end, and directly or indirectly by a kind of sterigma at the septa. These sporidia soon develop again into the ordinary form of septated promycelium, and the latter being easily detached repeats the growth as above described when the nutrients in the culture medium are not exhausted or when they are removed into a fresh nutrient solution.

Throughout the numerous culture experiments with both water and nutrient solution, the formation of aërial conidia has not been observed.

Though it is not yet shown experimentally in what way the infection by the present smut fungus takes place, it might be possible to consider that the sporidia produced on the promycelium of the spore, which escaped by the wind or the rain from the smutted branches in the preceeding season or year into the ground in the vicinity of the bamboo forest, are brought in contact with the young soft branches by the wind, and after obtaining the proper moisture, the germinated sporidia make their entrance into the soft tissues of the branches by means of the germ-tube.

From the mode of germination of the spores, it appears that the present smut fungus belongs decidedly to the Hemiustilago Brefeld.*

As a result of the study of this smut fungus, we are forced to make some changes in the original description of Ustilago Shiraiana *Henn*, as follows:

Ustilago Shiraiana *P. Henn.*

Fungi jap. I. Engler's Bot. Jahrbüch. 28 Bd. 3 Heft. p. 260. 1900; Sacc. Syll. Fung. XVI. pars V. p. 369. 1902; Ideta Lehrbuch. d. Pflanzenkrankh. (japanisch) p. 156. 1903; Omori et Yamada Pflanzenpath. (japanisch) p. 251. 1904.

Produced on the growing points and internodes of the young branches, causing often deformation or distortion; spore-masses at first covered by the leaf-sheath and bracts, pulverulent, deep brown; spores spherical, sometimes subglobose or elliptical, the rounded ones 6—10 μ. in diameter, and the elongated ones 5.5—10=6—12 μ. in size.

Epispore light olivaceous, smooth; contents finely granular with some oil globules; promycelium cylindrical or long fusiform, pedicellated, 1—2 septated, evanescent; sporidia terminal and lateral, long fusiform or elliptical, develop into the new promycelium.

Hab. on Phyllostachys puberula *Munro* Prov. Musashi (T. Makino May 1894), Prov. Mino (Y. Tanaka July 1894), Prov. Harima (K. Watanabe May

* Brefeld, Untersuch. a. d. Gesammt. d. Myk. XII Heft, p. 218. 1895.

1900), Prov. Idzumo (F. Tanaka June 1900), Prov. Harima (K. Watanabe May 1901), Prov Idzumo (F. Tanaka May 1902), Prov. Bingo (S. Hori June 1902), Prov. Yamato (S. Nakano July 1902), Prov. Bitchu (Z Shō July 1902), Prov Idzumi (reg? June 1904); Ph. bambusoides *Sieb. et Zucc.* Prov. Yamato (T. Jinno July 1897), Prov. Harima (K. Watanabe May 1900), Prov. Kaga (R. Taniguchi June 1900), Prov. Musashi (S. Hori August 1900), Prov. Sanuki (S. Hori June 1902), Prov. Awa (S. Hori June 1904); Sasa ramosa *Makino et Shibata* Nikko Prov. Shimotsuke (M. Shirai June 1899), Prov. Rikuchu (G. Yamada June 1903), Prov. Mutsu (N. Nambu June 1903); Arundinaria Simoni *Riv.* var. Chino *Makino et Shibata* Prov. Kai (S. Hori May 1904), Prov. Musashi (N. Nambu May 1904).

Prevention.

It is a matter of high importance that the smutted branches which are still covered by the leaf-sheath, that is before the spore-masses are scattered away by the opening of the leaf-sheath, should be cut off and burnt. The continuous careful removal of the immature smutted branches may possibly reduce the damages.

Since the smut on Sasa and Arundinaria growing on the road sides or hills and that on the cultivated Phyllostachys is identical, it is also important to take off the smutted branches on Sasa and Arundinaria growing near the vicinity of a Phyllostachys forest.

Spraying with Bordeaux mixture, at the time when the spring buds just begin to develop, should be beneficial. Sprinkling of lime on the ground of the bamboo forests after clearing it from the defoliated leaves just before the spring buds burst, should also be effectual to some extent.

I am indebted to Mr. T. Makino for the identification of the species of bamboo prepared to the specimen, and to Prof. Dr. M. Shirai, Dr. G. Yamada, and Mr. N. Nambu and many others for kindly supplying me with the specimens.

Explanation of Figures.

Plate IX.

Fig. 1. Earlier stage of the smutted branches of Phyllostachys puberula *Munro* still covered by the leaf-sheathes and bracts. The specimen collected by Mr. T. Makino May 6, 1894 at the vicinity of Tokio.

Fig. 2. Later stage of the severly smutted branches of Ph. puberula *Munro*. Osaka specimen collected June 13, 1904.

Plate X.

Fig. 1. Smutted and flowered branchlets on the same branch of Ph. bambusoides *Sieb et Zucc.* The specimen collected by Mr. K. Watanabe May 20, 1900 in the Prov. Harima.

Fig. 2. Smutted branches of Sasa ramosa *Mak. et Shib.* The specimen collected by Dr. G. Yamada June 21, 1903 at Morioka in the Prov. Rikuchiu.

Plate XI.

Fig. 1. Earlier stage of the smutted spring branches of Ph. puberula *Munro*; the spore-masses are still covered by the leaf-sheathes and bracts.

Fig. 2. Later stage of the smutted spring branches of Ph. puberula; the spore-masses on the internodes are brought in sight by the opening of the leaf-sheathes and bracts.

Fig. 3. Long branches of Ph. bambusoides *Sieb et Zucc.* smutted only on their upper portions showing that the disease occurred late in the season.

Plate XII.

Fig. 1. Germination of the spore in water observed continuously after 12–20 hours. (Zeiss F × 4).

Fig. 2. Germination of the spores in water after 24 hours. Promycelia pedicellated and some of them are 1–septated. (Zeiss F × 4).

Fig. 3. Germinated spores in ame-solution after 24 hours. Secondary promycelia produced are still attached. (Zeiss F × 4).

Fig. 4. Same culture as above after 48 hours. (Zeiss F × 4).

Fig. 5. Detached promycelia in ame-solution produced the sporidia directly or by the knee-joint fusion after 48 hours. (Zeiss F × 4).

Fig. 6. Detached promycelia cultured in the fresh ame-solution observed after 4 days.

1

2

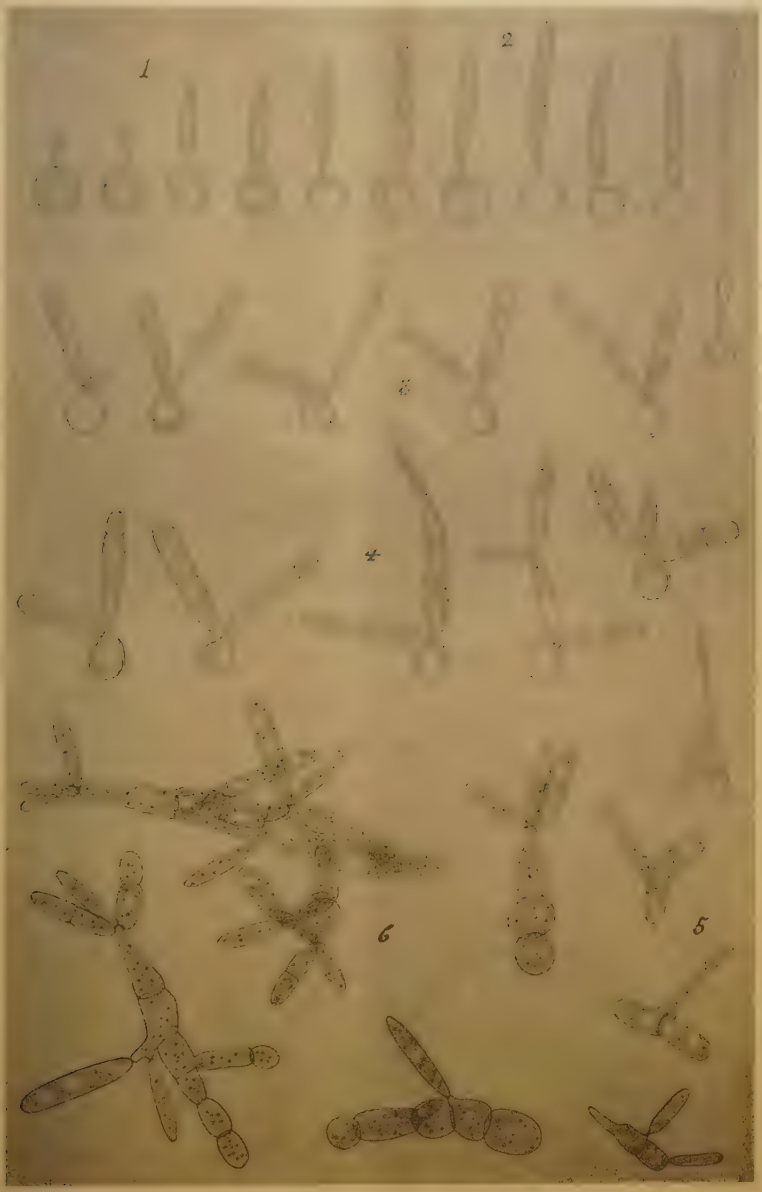
S. Hori Photo.

1

2

S. Hori Photo.

S. Hori del.



S. Hori del.

本邦に於ける麥類銹病の種類に就て

高　橋　良　直

NOTES ON CEREAL RUSTS IN JAPAN.

(With an English résumé).

Y. TAKAHASHI.

Botanist to the Hokkaido Agricultural Experiment Station, Sapporo.

余は植物學雜誌第二百十三號(明治三十七年十月發行)に於て、歐洲に存在する六種の麥類銹菌が悉く本邦に產することを述べしが、今又此小報を公にし聊か作物病害の研究に從事する人々の參考に供せんとす。

本邦に於て見出さるゝ麥類銹病の種類を擧げ其特徵を記すれば次ぎの如し。但し各種銹菌の條下に擧ぐる標品は、宮部博士の手元に集積せるものと、余の有するものとを合したるものなり。

(1) 黃銹。　これ白井氏のきはしぶと稱するものにして、小麥、大麥、裸麥、らいむぎ及び數種の禾本植物を害す。

病原菌は *Puccinia glumarum* (Schm.) Eriks. et Henn. と稱し、ERIKSSON 氏は之れを若干の變種に分つ。即ち(イ)小麥を侵すもの、(ロ)大麥及び裸麥を侵すもの、(ハ)らいむぎを侵すもの、及び他の禾本科植物に寄生する一二の變種是れなり。但し此等の變種は其外形に於ては全然同一なるも生態的に異なれり。即ち(イ)は小麥に寄生するのみにして大麥、らいむぎ等に寄生することなく、(ロ)は大麥及び裸麥に寄生するも其他の麥類に寄生せざるが如き之れなり。

黃銹菌の銹胞子 (Uredospores) は多くは楕圓形の集團 (Sori) を爲

[Trans. Sapporo Nat. Hist. Soc., Vol. I, 1905.]

して葉の兩面に生じ、此等の集團は其色黃にして規則正しく線狀に縱列す。之れ黃銹の一大特徵なり。銹胞子發生の初めに於ては其集團顯著ならざるを以て、細視せざれば恰も黃色の條斑を生ぜるが如き觀あり。銹胞子は又子實の穎片(Glumes)、秈等にも生ずれども、此等の場合に於ては唯不規則なる集團を爲すのみなり。

銹胞子は球形若しくは少しく楕圓に傾き其長さ十八「ミュー」位より二十八「ミュー」位に達し、其內容は黃色を帶ぶるも膜は透明にして表面に刺あり。發芽孔は數個あれども見易からず(KLEBAHN 氏の說によれば發芽孔は八個乃至十個、若しくは十二個に達することあり)。刺の距離は一·五「ミュー」、膜の厚さも同じく一·五「ミュー」あり。

次に終局胞子(Teleutospores)の集團は黑色の小點となりて現はれ、葉鞘上に縱にならび規則正しく線狀を呈す。是れ此銹菌の特徵の一なり。但し右集團は葉面にも生ずることあれど、此場合に不規則に散在す。此等の集團は表皮の下に生じ、彎曲せる棍棒狀の絲狀體(Paraphyses)によりて二三の小房に區劃せられ、其周圍にも同樣の絲狀體あり、而して永く表皮に蔽はれ外部に露出することなし。終局胞子は黃褐色を帶び、其形左右齊整ならずして、多くは一方に曲り、其上端或は扁平なるあり、細長く延長せるあり、一二の短小なる突起を有するあり、或は又不規則に角張れるありて頗る多樣なれども、概して上位の細胞と下位の細胞との間に多少の縊れを有し且つ胞子上端の膜は著しく厚きを常とす。終局胞子は其長さ四十乃至七十「ミュー」以上、幅は十五六「ミュー」乃至二十五六「ミュー」に達し、柄は甚だ短小なり。

黃銹は本邦各地に普通に發生し、小麥、大麥、裸麥を害するを見る。就中小麥は最も多く之れに侵され、大麥は之に侵さるること一體に少し。裸麥の被害も亦頗る普通なり。

余等の手元にある標本の出處を示せば下の如し。但しIIは銹胞子時代、IIIは終局胞子時代を示す。以下皆同じ。

小麥——熊本縣飽託郡出水村(II. 明治三十七年五月十日、吉野毅一氏)、愛媛縣松山(II. 明治三十六年四月、千石興太郎氏)、島根縣(III. 明治三十六年、長崎常氏)、兵庫縣飾磨郡國府寺村(II. III. 明治三十四年六月十日、高橋頁直)、大坂(II. 明治三十八年六月十二日、出田新氏)、東京小石川植物園(明治三十二年六月四日、草野俊助氏)、新潟縣三島郡寺泊町(II. 明治三十六年四月十三日、吉野毅一氏)、仝古志郡福戶村(II. 明明三十六年六月、吉野毅一氏)、岩手縣盛岡(II. 明治三十七年、關待初郎氏)、秋田縣(II. III. 明治三十七年、德淵永次郎氏)、青森縣(III. 明治三十六年、中村鐵太郎氏)、石狩國札幌(II. III. 明治三十六年七月以後、高橋頁直)、天鹽國初山別(II. 明治三十六年七月二十一日、高橋頁直)。

裸麥——福岡縣福岡(II. 明治三十八年六月、黑澤良平氏)、愛媛縣松山(II. 明治三十六年四月、千石興太郎氏)、東京(II. 明治三十二年六月四日、草野俊助氏)、長野縣下高井郡(II. 明治三十六年六月、村山某)、石狩國對雁村(II. 明治二十八年七月、宮部金吾氏)、石狩國札幌(II. 明治三十三年七月二十日、結城庄八氏)、仝上(II. III. 明治三十六年七月以後、高橋頁直)、天鹽國增毛(II. 明治三十六年七月二十日、高橋頁直)、仝ウタコシベツ村(III. 明治三十六年七月二十二日、高橋頁直)。

大麥——熊本縣(III. 明治三十七年、吉野毅一氏)、石狩國札幌(II. 明治三十六年七月)。

因に記す、此銹菌の腔胞子時代(Aecidium-stage)は未だ發見せられざるなり、恐くは全然之れを缺如するものならん。

(2) 黑銹。 是れ白井氏のくろはしぶと稱するものにして、小麥、裸麥、大麥、燕麥、らいむぎ及び諸種の禾本植物を害す。

病原菌は *Puccinia graminis* Pers. にして、ERIKSSON 氏は之れを若干の變種に分つ。即ち(イ)らいむぎ及び大麥、裸麥を侵すもの、(ロ)主として小麥を侵すもの、(ハ)燕麥及び二三の禾本科植物を侵すもの、外に他の禾本科植物に寄生する二三の變種是れなり。

黑銹菌の銹胞子は細長き赤銹色の集團を爲して葉面葉鞘等に生じ、集團は不規則に散在し其長さ四五厘以上に達することあり。銹胞子は楕圓形を呈し、其長さは三十「ミュー」以外乃至五十「ミュー」位、幅は十五六「ミュー」乃至三十「ミュー」位なるを以て、其長さは大抵幅の二倍內外あるを常とす。胞子膜は灰黃色を呈し、二「ミュー」內

外の厚さを有し、表面に細刺を帶び、刺の距離は二「ミュー」内外あり。又發芽孔は四個ありて(KLEBAHN 氏の說によれば稀れに三又は五個のことありと)胞子の中央部(赤道)に互に同距離を隔てゝ相對す。斯かる排置は他の種類には之れ無し。

終局胞子の集團は稈及び葉鞘に生じ、細く延長し、表皮に蔽はれずして外間に露出し、黑色を呈す。各胞子は褐色を帶び、其長さ四十乃至七十「ミュー」位、幅は十五乃至二十五「ミュー」に達し、其柄は透明にして非常に長きを以て他の種類より見分くること極めて容易なり。

黑銹は本邦に於ては大害あるを見ず、盖し其發生甚だ遲くして大抵寄主の成熟に近つける頃なるを以てなり。

余等の手元にある標本の出處を記すれば下の如し。

小麥——熊本縣飽託郡大江村(III. 明治三十七年六月十九日、吉野毅一氏)、同地方(II. III. 明治三十八年六月、吉野毅一氏)、福岡縣福岡(II. 明治三十八年六月十五日、黑澤良平氏)、鹿兒島縣農事試驗場圃(III. 明治三十六年七月三日、西田藤次氏)、石狩札幌郡白石村(III. 明治二十七年八月二十五日、平塚直次氏)、石狩札幌(II. III. 明治三十七年八月十七日以後、高橋眞直)。

此の如く余等の有する被害標本はすべて小麥に屬し、大麥裸麥等の被害標本は一も之れを有せず。盖し本邦にては小麥以外の麥類が全く黑銹に侵されずとは言ふ能はざるも、其被害の少きは疑を容れず。

人の知る如く、黑銹菌の腔胞子時代は *Berberis* 上に現はるゝものにして、余等の手元には札幌、函館、磯谷(後志國)及び樣似(日高國)にて採集せるとりとまらず(*Berberis vulgaris*)に寄生せる該時代の標品あり。

(3) **小麥の赤銹**。　一に褐色銹(Brown rust)又あかはしぶと稱するものにして、病原菌は *Puccinia triticina* Eriks. と稱し小麥に特有なるものとす。

銹胞子集團は赤褐色若しくは黄褐色を呈し不規則に葉面殊に其上面に生じ、不規則に散在し、三四厘の長さに達す。胞子は概して圓く、其表面に細微なる刺を有し、數個の發芽孔を具ふ。胞子膜は始め無色透明なるも老成すれば褐色を帶ぶ。かゝる胞子を壓し潰して空虚にすれば、容易く發芽孔の存在及び膜の褐色を呈することを看取するを得べし。銹胞子は其直徑二十四五「ミュー」乃至二十八「ミュー」位なり。

終局胞子の集團は黒色の小點狀を爲し、主として葉面又多少葉鞘にも生じ、不規則に散在し、表皮に蔽はれあるは黄銹に同じ、胞子は淡褐色を帶び、黄銹に於けるが如く彎曲せるもの少く、又其上端は濃褐色にして概して扁なるもの多く、其下端即ち柄に接する所も亦濃褐色を有す。胞子の長さは三十「ミュー」乃至五十「ミュー」位、幅は十五乃至二十「ミュー」あり。柄は至つて短し。

此種類は札幌地方にては最も普通に發生し大害をなす。

標品の出處下の如し。

福岡縣福岡(III. 明治三十八年六月十五日、黒澤長平氏)、熊本縣飽託郡出水村(III. 明治三十七年五月八日、其他、吉野毅一氏)、兵庫縣飾磨郡國府寺村(II. 明治三十四年六月十一日、高橋眞直)、大阪(II. 明治三十八年六月十二日、出田新氏)、岐阜縣大野村上枝村、明方村(II. 明治三十二年五月、山口某)、東京小石川(II. III. 明治三十二年六月四日、草野俊助氏)、東京西ヶ原(II. III. 明治三十五年六月七日、吉野毅一氏)、東京八王子附近(III. 明治三十六年六月十一日、草野俊助氏)、新潟縣古志郡長岡(II. 明治三十六年五月八日、吉野毅一氏)、秋田縣秋田八橋村(II. 明治三十五年六月五日、德淵永次郎氏)、贈振國有珠郡長流村(II. III. 明治三十二年七月二十三日、山田玄太郎氏)、後志國岩内郡發足村(III. 明治二十五年八月、近藤某)、石狩國札幌(II. III. 明治二十五年以後、中野德一氏、德淵永治郎氏、宮部金吾氏、山田玄太郎氏、結城庄八氏、高橋眞直、)石狩郡花川村(II. 明治三十八年七月、鵜牧安治氏)、石狩上川郡旭川(II. 明治三十二年十月一日、川上瀧彌氏)、仝上川郡永山村(II. 明治三十七年七月二十五日、高橋眞直)、

此銹菌も腔胞子は未だ發見せられざるものなり。

(4) 大麥裸麥の赤銹。 大麥及び裸麥の赤銹は「矮形銹病」「小銹」

等の異名を有するものにして、病原菌は *Puccinia simplex* (Körn.) Eriks. et Henn. と稱し大麥裸麥に特有なるものなり。

此菌の銹胞子集團は黃褐色を呈し、不規則に葉面に散在し、其形甚だ少さく僅々一二厘の長さあるに過ぎず。胞子は圓形若しくは楕圓形にして、圓きものは直徑二十「ミュー」內外、楕圓のものは其長さ二十乃至三十二「ミュー」位にして、褐色を帶び、表面に刺を有し、數個の發芽孔を具ふ。刺と刺との距離は一半乃至二「ミュー」、胞子の膜の厚さは一半「ミュー」內外あり。

終局胞子は葉鞘若しくは葉面に生じ、表皮に蔽はれ微小なる黑點狀の集團をなし、其排列に一定の規則なし。胞子は褐色を帶び他の何れの種類とも異にして、多くは單一の細胞より成り、其形一定せず。其長さは二十八乃至四十「ミュー」位、幅は十六乃至二十五「ミュー」位あり。

要するに此銹菌は其銹胞子集團の小なること、終局胞子の概して一室より成ることを以て特徵とす。腔胞子時代の發見せられざるは黃銹及び小麥赤銹に同じ。

標品の出處を記すれば下の如し。

大麥——熊本縣飽託郡砂取町(H. 明治三十七年五月廿六日、吉野毅一氏)、仝熊本(H. 明治三十八年五月二十五日、仝氏)、茨城縣稻敷郡君原村(H. 明治三十一年十二月二十五日、石引業)、札幌(H. III. 明治三十七年八月一日、其他、高橋貞直)。

裸麥——熊本(H. III. 明治廿七年五月十一日、其他、吉野毅一氏)、兵庫縣姬路(H. 明治三十四年六月十一日、高橋貞直)、大阪(H. 明治三十七年、出田新氏)、相州永井村(H. 明治廿四年五月四日、宮部金吾氏)、釧路國ルリラン(H. 明治二十七年七月二十九日、宮部金吾氏)、札幌(H. 明治二十八年八月、宮部金吾氏)、仝(H. III. 明治廿六年七月十三日、其他、高橋貞直)、石狩國上川郡永山村(H. 明治三十七年七月二十五日、高橋)、仝上川郡比布村(H. 明治三十七年七月二十七日、高橋)、天鹽國初山別(H. 明治三十六年七月二十一日、高橋)、仝增毛(H. 仝月廿日、高橋)、奥尻(H. 明治二十三年七月廿七日、宮部金吾氏)。

(5) らいむぎの赤銹。　是れ亦褐色銹とも呼ぶものにして、病

原菌は *Puccinia dispersa* Eriks. et Henn. と稱しらいむぎに特有なるものとす。

銹胞子は赤褐色の集團を爲し主として葉の兩面に生じ、集團及び胞子の外觀形狀等は小麥赤銹菌の其れに類せり。

終局胞子は微小なる黑點狀の集團を爲して葉鞘に生じ、余は未だ其葉に生ぜるを見しことなし、表皮に蔽はる。胞子は短柄を有し赤褐色を帶び、其長さ四十「ミユー」より六十「ミユー」までのもの最も多く、幅は二十「ミユー」內外あり。

此銹菌は歐洲にては紫草科植物 *Anchusa arvensis* 及び *A. officinalis* に其腔胞子を生ずるものにして、該胞子の發生するは八九月頃なるに拘らず秋蒔らいを侵すこと極めて少く、翌年六月に至り盛に之れを侵すと云ふ。去れば本銹菌が如何なる狀態にて越年するやは一の疑問なり。而して北海道に於ては札幌農學校及び北海道農事試驗場にて試作するらいむぎは年々之に侵され、盛に銹胞子を生ずるも終局胞子を生ずること極めて稀れなり。若し夫れ此菌の腔胞子時代に至りては、余等は未だ之れを北海道に於て發見せず。思ふに本銹菌は札幌地方にては銹胞子の狀態にて越年するものにあらざるか。余は未だ實地試驗によりて此事を確かめずと雖も、Bromus 類に寄生する赤銹菌の銹胞子が冬を凌ぐの力あるは MARSHALL WARD 氏の觀察せる所、又葱銹菌 *Puccinia Porri* の銹胞子が札幌地方の冬を凌ぐの力あるは余の實見せる所なり。

らいむぎは本邦に於ては特殊の場所に試作せらるゝに過ざるを以て、此銹菌は現時重要なる病害にあらざるは勿論なり。而して余等の標品は凡て北海道に於て採集せるに係り、府縣より來れるものは一も之れ無し。今其採集地を擧くれば下の如し。

石狩國上川郡永山村（II. 明治三十七年七月二十五日、高橋眞直）、全札幌（II. 明治二十八年六月十五日、德淵永治郎氏、其他西田藤次氏、山田玄太郎氏、高橋眞直）、札幌（III 明治三十七年八月二十七日、高橋眞直）。

(6) **燕麥の冠狀銹**。　燕麥其他禾本科植物に寄生する冠狀銹(Crown rust)は以前はすべて一種(*Puccinia coronata* Corda)と見做されしが、KLEBAHN 氏之れを(甲) *P. coronifera* Kleb. と(乙) *P. coronata* (Corda) Kleb. との二種に分ちたるは人の知る所なり。(甲)は其腔胞子を *Rhamnus cathartica* 上に生じ、(乙)は之れを *Frangula Alnus* 上に生ずるものにして、銹胞子及び終局胞子時代に於ても其外形上兩種の間に多少の相違あり。而して ERIKSSON 及び KLEBAHN 氏の研究によれば *P. coronifera* の中にも若干の變種ありて、燕麥に寄生するものは *P. coronifera Avenae* Eriks. 是れなり。要するに KLEBAHN 氏の研究に從へば、燕麥の冠狀銹菌は *P. coronifera* に屬するものなり。外に一の「ヴアライテー」あり。*P. coronata* var. *himalensis* Barclay 是れなり。而して本邦のくろうめもどき(*Rhamnus japonica*)に寄生する Aecidium は從來 *P. coronifera* の腔胞子時代即ち *Aec. Rhamni* Gmel. に該當するものと思惟せられしが、近頃 P. DIETEL 氏はくろうめもどきに生ぜる Aecidium を日本より得之れを *P. himalensis* (Crda.) Dietel (=*P. coronata* var. *himalensis* Barcl.) に屬するものと査定し、其後更に又我邦より同寄主に生ぜる Aecidium を得之れを新種と爲し *Aec. Rhamni japonici* と命名せり。果して然らばくろうめもどきの Aecidium は燕麥の銹菌と全く無關係なるや、將又以上二種の *Aecidium* の外 *Aec. Rhamni* Gmel. も亦くろうめもどきに寄生するや。此等の疑問は今之れを解決する能はざるも、兎に角余等が札幌にて見る所の燕麥冠狀銹は少くとも其銹胞子時代に於て *P. coronifera* に吻合するを見るなり。但し P. MAGNUS 氏は此種の本名として *P. Lolii* Niels. を用ゐ *P. coronifera* を以て其別名と爲すべきを指摘し、SYDOW 氏の銹菌譜にも *P. Lolii* を本名と爲しあれども、余輩は姑らく *P. coronifera* を用ゆる事とし、其性狀を記すれば下の如し。

銹胞子集團は葉の兩面に不規則に散在して生じ、黃褐色を帶び、胞子は圓形又は短楕圓形を有し圓形のものは其直徑二十乃至

三十「ミュー」に達し、黄色にして表面に微小なる刺あり。膜は透明にして約二「ミュー」の厚さを有し、發芽孔は三四個あり。次に終局胞子は黒色の小點をなして葉に生じ、一種特別の形狀を有するを以て容易く之れを識別するを得。特別の形狀とは胞子の上端に數個の角狀突起を有すること是れなり。但し此特徴が *P. coronifera* にも *P. coronata* にも共通なるは言を俟たず。

KLEBAHN 氏の説によれば *P. coronata* (Corda) Kleb. の銹胞子は葉の下面に生じ、之れに反して *P. coronifera* の銹胞子は葉の兩面に現はれ、加之 *P. coronata* (Corda) のより少しく大にして且つ顯著なる集團を爲す。次に終局胞子時代に於ける兩種の相違を見るに *P. coronata* (Corda) の終局胞子集團は點狀若しくは短線狀を呈し、*P. coronifera* の其れは銹胞子集團の周圍に不規則なる輪狀を爲すの差あり。若し夫れ *P. himalensis* に至りては其胞子小形なるのみならず、終局胞子集團は表皮に蔽はれずして裸出する特徴あり。

標品の出處を擧くれば下の如し。

熊本縣阿蘇(III. 明治三十四年八月、川上瀧彌氏)、仝鮑託郡出水村(III. 明治三十七年七月十三日、吉野毅一氏)、石狩國札幌(II. 明治二十五年十月、宮部金吾氏)、仝(II. 明治三十七年八月廿四日、其他、高橋眞直)。

上記標本中札幌にて採集せる銹胞子時代のものを見るに前述の如く其形狀 *P. coronifera* に吻合するを見るも、未だ終局胞子時代のものを手に入れざるを憾みとす。然るに熊本地方より來れる標品を見るに、其外觀は却つて *P. coronata* (Corda) に類するが如し。此等の事に就ては今後研究の上更に報告すべし。猶又札幌邊にては上記銹菌の發生期甚だ遲きを以て燕麥耕に對しては實際上無害なり。

今麥類一種つゝに對し之れを侵害する銹病の種類を表示すれば下の如し。

小　麥 — *Puccinia graminis*（黑銹）
　　P. glumarum（黃銹）
　　P. triticina（赤銹）

大　麥
裸　麥 — *P. graminis*（黑銹）
　　P. glumarum（黃銹）
　　P. simplex（赤銹、小銹、矮形銹）

らいむぎ — *P. graminis*（黑銹）
　　P. glumarum（黃銹）
　　P. dispersa（赤銹）

燕　麥 — *P. graminis*（黑銹）
　　P. coronifera（冠狀銹）

上に記したる如く各種の麥を害する銹病は三種若しくは二種ありて、札幌地方にては小麥、大麥等は同一莖葉に赤銹と黃銹を混生すること珍らしからず。今便宜のため以上六種の銹菌の檢索表を揭ぐれば下の如し。

甲、銹胞子 (Uredospores) による檢索表。

一、銹胞子集團は黃色を呈し、規則正しく併列して葉面に線狀をなす……*P. glumarum.*

二、銹胞子集團は不規則に散在し、黃色を呈せず

A、銹胞子は長楕圓形を呈し、長徑は大抵短徑の二倍內外めり……*P. graminis.*

B、銹胞子は圓形若しくは短楕圓形を有す

(イ) 小麥を侵すもの……*P. triticina.*

(ロ) 大麥、裸麥を侵すもの……*P. simplex.*

(ハ) らいむぎを侵すもの……*P. dispersa.*

(ニ) 燕麥を侵すもの……*P. coronifera.*

乙、終局胞子 (Teleutospores) による檢索表。

一、終局胞子集團は寄主の表皮の外に露出し、其表面黑粉狀を呈す ……*P. graminis.*

二、終局胞子の集團は表皮に覆はれ、從つて其表面は粉狀を呈せず

A、終局胞子の集團は葉鞘に生じ線狀に併列す *P. glumarum.*

B、終局胞子の集團は葉面若しくは葉鞘に生じ線狀に併列せず

(イ) 終局胞子は多くは一室より成る ……*P. simplex.*

(ロ) 終局胞子は二室より成る

○胞子は其上端に角狀突起を有す …. *P. coronifera.*

○○胞子は突起を有せず

△ 小麥を侵すもの ……*P. triticina.*

△△らいむぎを侵すもの ……*P. dispersa.*

終りに臨み、余は本稿を草するにあたり宮部博士より有益なる助言を得たることと、博士の手元に集れる標品を貸與せられたるとに就て謝意を表し、且つ本文に記したる胞子の形狀、大さ等は北海道農事試驗場に於て余の調査せる所に從へることと、大方の諸賢に對し標品の寄與を希望するの極めて切なることを茲に附記す。

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RÉSUMÉ.

Puccinia graminis **Pers.**, *P. glumarum* (**Schm.**) **Eriks.** et **Henn.**, *P. triticina* **Eriks.**, *P. dispersa* **Eriks.**, *P. simplex* (**Körn.**) **Eriks.** et **Henn.** and *P. coronifera* **Kleb.** are all found in Japan. In other words, all the species of the cereal rusts reported from Europe occur on our grain crops.

Generally speaking, of these six species, *P. glumarum* is the most common in Japan, attacking wheat and barley to a large extent. *P. triticina* and *P. simplex* are of common occurrence in Hokkaidō, seriously attacking their respective host. These two species are found also in Honshū (the Main Island).

P. graminis appears on wheat much later than either *P. glumarum* or *P. triticina* both in Honshū and Hokkaidō, and causes a very little or almost no damage to the crop. *P. coronifera* is also practically of no economic importance in Japan. So far *P. dispersa* is known only from Hokkaidō, where rye is cultivated at some places for experimental purposes. The aecidium stage of this species, however, is not yet found by us, and its teleutospores are very rarely formed in Hokkaidō, as far as my observation is concerned. The fact may be that the fungus passes the winter in its uredo stage.

Finally it must be added that at present nothing is known about the relation of our oat rust to *Aecidium Rhamni japonici* **Diet.**, which occurs on *Rhamnus japonica* in Japan. Aecidium-form of *Puccinia himalensis* (**Barcl.**) **Diet.** has also been reported by **DIETEL** on the same host from Japan.

Sapporo, Nov. 25, 1905.

日本産フラグミディューム屬に就きて

笠　井　幹　夫

（第一圖版）

CONTRIBUTIONS TO THE MYCOLOGICAL FLORA OF JAPAN. III. (1)

ON THE JAPANESE SPECIES OF PHRAGMIDIUM.

By

MIKIO KASAI, *Nōgakushi.*

(With Plate I.)

INTRODUCTION.

The observation which I propose to report upon in the following pages was undertaken with a view to revising the species of *Phragmidium* existing in our country, and, if possible, to correctly describing a few of them in a manner that can readily be of service to those who are interested in the subject.

Since DIETEL (8,9) recorded forty-six species of *Phragmidium* in his monographic paper in 1905, eight more species have been described; namely, *Ph. Rubi-Thunbergii* Kusano, *Ph. orientale* Sydow, *Ph. Butleri* Sydow, *Ph. Nambuanum* Diet., *Ph. Rosae-acicularis* Liro, *Ph. Rubi* var. *candicantium* Vleugel, *Ph. Rubi-saxatilis* Liro, and *Ph. Englerianum* Diet. Consequently about fifty four species have hitherto been known to the scientific world. Of these fifty four species, only ten have been supposed to belong to our flora.

In the present paper I have been able to increase the number of our species of *Phragmidium* to seventeen. Eleven of these are peculiar to Japan and three are new to science.

(1). Prepared under the direction of Prof. Dr. K. MIYABE. Contributions. I.–T. MIYAKE. On Puccinia Parasitic on the Umbelliferae of Japan. Journ. of the Sapporo Agric. Coll. Vol. II. Pt. 3. 1906. Contributions. II. S. ITO, On the Uredineae Parasitic on the Japanese Gramineae. Journ. of the Coll. of Agric., Tohoku Imp. Univ., Vol. 3, No. 2, 1909.

Ph. subcorticium (Schrank) Wint. and *Ph. Fragariastri* (DC.) Schroet., which were ascribed by DIETEL (11) and P. HENNINGS (14) to our flora, have not been found by us, notwithstanding careful search being made for them.

On *Rosa rugosa* Thunb. two forms of *Phragmidium* are commonly found in the vicinity of Sapporo. They have not been distinguished from each other, but have been identified collectively by most of our mycologists to *Ph. subcorticium* (Schrank) Wint. But a careful observation has disclosed the fact, that the so-called "*Ph. subcorticium*" is in reality composed of two distinct species with a clear line of demarcation between them. I am inclined to consider them as new species and propose to give them the names of *Ph. Rosae-rugosae* and *Ph. yezoense*.

The following seventeen species are found in our country:

On *Potentilla*.

1. *Ph. Potentillae* (Pers.) Karst.

On *Rosa*.

2. *Ph. americanum* (Pk.) Diet.
3. *Ph. fusiforme* Schroet.
4. *Ph. japonicum* Diet.
5. *Ph. Rosae-multiflorae* Diet.
6. *Ph. Rosae-rugosae* n. sp.
7. *Ph. yezoense* n. sp.

On *Rubus*.

8. *Ph. Barnardi* Plowr. et Wint. var. *pauciloculare* Diet.
9. *Ph. griseum* Diet.
10. *Ph. heterosporum* Diet.
11. *Ph. Nambuanum* Diet.
12. *Ph. Rubi* (Pers.) Wint.
13. *Ph. Rubi-Idaei* (Pers.) Wint.
14. *Ph. Rubi-japonici* n. sp.
15. *Ph. Rubi-Thunbergii* Kusano.
16. *Ph. Yoshinagai* Diet.

On *Sanguisorba*.

17. *Ph. carbonarium* (Schlecht.) Wint.

The materials, on which my present study was based, were mostly those preserved in the Herbarium of our College, which had been most kindly placed at my disposal by Professor Dr. K. MIYABE. Prof. M. SHIRAI, Prof. S. KUSANO and

Mr. T. YOSHINAGA also kindly supplied me on request with valuable specimens. And I have been able through the kindness of Mr. T. MIYAKE to examine a few Saghalien specimens. Thus the total number of the specimens at my disposal amounted to 205.

Now I wish here to express my hearty thanks to Prof. Dr. K. MIYABE who has helped and encouraged me throughout my work with many valuable suggestions and constant guidance and allowed me also the privilege of a free use of his library and collections. My obligation is also due to Prof. SHIRAI, to Drs. Y. TAKAHASHI, S. KUSANO, T. MIYAKE, and S. ITO and to Mr. T. YOSHINAGA, who all had the goodness to aid me in many ways in the preparation of this paper.

SPECIAL PARTS.

On **POTENTILLA.**

1. **Phragmidium Potentillæ** (Pers. Karst., Fung. Fenn., 1868, No. 94; Sacc., Syll., VII. p.743; Wint., Die Pilze, p.229; Schroet., Pilz Schles., p.352; Fischer, Die Urod. d. Schweiz, p.410; Plowr., British Ured. and Ustilag., p.221; McAlp., The Rusts of Australia, p.188; Diet. Engl. bot. Jahrb., Bd. 37, 1905, p.104; Diet., Ann. Mycol., Vol.6, 1908, p.227; P. Henn., Engl. bot. Jahrb., Bd.32, 1903, p.36.

   Icon: Fischer, Die Ured. d. Schweiz, p.410, fig. 286; Ludwig, F., Lehrbuch d. Nied. Kryptogamen, p.475, fig. 12.

   Hosts and distribution.

   On *Potentilla chinensis* Ser.

   Prov. Ise, Akogigaura (H. T. YOSHINAGA, Aug. 1904)

   Prov. Rikuchu, Ishinomaki (H. N. HIRATSUKA, Sept. 1901)

   On *Potentilla cryptotaeniae* Maxim.

   Prov. Oshima, Komuma (H. H. K. MIYABE, Sept. 28, 1899)

   Prov. Iburi, Chitose (H. K. MIYABE et S. ARIMOTO, Aug. 4, 1902)

   Prov. Iburi, Hayakita (H. K. MIYABE et S. ARIMOTO, Aug 4, 1902)

   On *Potentilla Dickensii* Fr. et Sav.

   Prov. Mutsu, Iwakiyama (H. K. KIKUCHI, Aug. 24, 1896)

   Prov. Mutsu, Iwakiyama (H. N. HIRATSUKA, Sept. 1899)

   On *Potentilla gelida* C. A. Mey.

   Prov. Iburi, Matkarinupri (H. H. S. ITO, Aug. 1907)

On *Potentilla Kleiniana* W. et A.

Prov. Tosa, Kamoda-mura (H. T. YOSHINAGA, May. 1903)
„ „ Asakura-mura (H. „ Nov. 1907)
Prov. Iyo, Ebara-mura (H. M. OKUDAIRA, May 22, 1899)

REMARKS:— This is the only species in our country found parasitic on several species of *Potentilla*. I rather hesitate to believe, as will be referred to in the conclusion, the existence of *Ph. Fragariastri* (DC.) Schroet. in Japan, although P. HENNINGS (14.) recorded its occurrence.

On ROSA.

2. **Phragmidium americanum** Pk. Diet., Hedwigia, Bd. 44, 1905, p. 124.

Icon: Diet., Hedwigia, Bd. 44, 1905, pl. IV. fig. 5.

Teleutosori hypophyllous, small, loose, scattered or aggregated, black; teleutospores fusiform or cylindrical, cells 8-10, rarely 7 and 11, septa comparatively thin, base attenuated, apex with a sharp or blunt yellowish papillum (12 mmm. long), membrane dark-brown, thick, provided with many rather small colorless warts, not constricted at septum, the uppermost cell is often longer than the rest, germpores 3 in each cell, 80-100 × 28-32 mmm., pedicel pale-yellow in the upper part, firm, bulbous, longer than the spore length, up to 140 mmm.

Host and distribution.

On *Rosa dahurica* Pall.

Prov. Nemuro, Shumbetsu (H. K. MIYABE, Aug. 6, 1894)
Saghalien, Sausuchainoskoe (H. T. MIYAKE, Oct. 8, 1907)

REMARKS:— Our plant corresponds exactly in every respect to the specimens of *Ph. americanum* Pk.) Diet. and there remains but little doubt as to their identity. The present species is more or less closely related to *Ph. yezoense*, n. sp., *Ph. fusiforme* Schroet. and *Ph. Rosae-multiflorae* Diet. But from *Ph. yezoense* n. sp it differs in form of papilla, the size of warts and also the number of cells. From *Ph. fusiforme* Schroet. the number of cells and the form of the uppermost cell appear to warrant sufficient disagreement. *Ph. Rosae-multiflorae* Diet. again varies from this species in respect of the color and form of pedicel and the number of cells.

F. von THÜMEN (26) recorded the occurrence of *Ph. subcorticium* Schrank) Wint. upon *Rosa dahurica*. But the species in question, though parasitic on the same host plant, sufficiently proves beyond doubt its identity to *Ph. americanum* (Pk.) Diet. rather than to *Ph. subcorticium* (Schrank) Wint.

3. **Phragmidium fusiforme** Schroet., Brand- und Rostpilze Schles., p.24; Schroet., Pilze Schles., p.354; Sacc., Syll., VII. p.747; Plowr., British Ured. and Ustilag., p.256; Fischer, Ured. d. Schweiz, p.404; Diet., Hedwigia, Bd.44, 1905.

Icon: Fischer, Ured., p.405, fig.283; Dietel, Hedwigia, Bd.44, 1905, pl. IV. fig.3; Ludwig, F., Lehrb. d. Kryptogamen, p.465, fig.18.

Host and distribution.

On *Rosa acicularis* Lindl.

Prov. Iburi, Mukawa (H. HI. C. YENDO, Aug. 24, 1895)

Saghalien, Vladimirohuka (H. HI. T. MIYAKE, Aug. 22, 1906)

REMARKS:— The present species was idenified several years ago by Prof. Dr. K. MIYABE and Mr. T. MIYAKE. Its occurrence in Japan, I believe has not yet been published in any paper. DIETEL states that the fungus is known so far to be restricted to the central Europe. It should therefore be of special interest to find it out in north Japan. The present species will readily be recognised by its many celled and thin septated teleutospores. E. M. FREEMAN gives us an account of *Ph. subcorticium* (Schrank.) Wint. on *Rosa acicularis* from Minnesota, U. S. A. But the character of our type leaves no doubt about its identity with *Ph. fusiforme* Schroet.

4. **Phragmidium japonicum** Diet., Engl. bot. Jahrb., Bd. 27, 1900, p.567; P. Henn., Engl. bot. Jahrb., Bd. 31, 1902, p.732; Sacc., Syll., XVI. p.316.

Icon: Dietel, Engl. bot. Jahrb., Bd. 27, 1900, pl.VI. fig.8.

Hosts and distribution.

On *Rosa multiflora* Thunb.

Prov. Hizen, Omura (HI. Y. OKA, May. 1897)

Prov. Harima, Himeji (HI. Y. TAKAHASHI, June 10, 1899)

Prov. Sagami, Misaki (HI. N. HIRATSUKA, Aug. 6, 1898)

Prov. Musashi, Hodogaya (HI. T. MIYAKE, July 27, 1903)

Prov. Ugo, Warabioka (HI. K. MIURA, Aug. 27, 1905)

„ „ Mt. Chokai (HI. „ „ „)

On *Rosa Wichuriana* Crep.

Prov. Tosa, Kodono (HI. T. YOSHINAGA, May 18, 1908)

Prov. Mino, Gifu (HI. E. TOKUBUCHI, June 3, 1899)

Prov. Suruga, Gotemba (HI. K. MIURA, July 12, 1907)

„ „ Fujisan (HI. „ „ 13, „)

Prov. Musashi, Tokyo HI. S. KUSANO, Oct. 16, 1898)

„ „ Hodogaya (HI. T. MIYAKE, July 26, 1903)

On *Rosa Luciae* Fr. et Sav.

Prov. Settsu, Kobe (III. K. MIYABE, Sept. 5, 1899)

Prov. Awa, Mera (III. K. MIYABE, July 29, 1893)

REMARKS: This endemic species was described by DIETEL in 1900 from a specimen collected by S. KUSANO in Tokyo. It is widely distributed throughout Honshū, Shikoku, and Kiushū. But it has not been found in Hokkaido so far. The fact, that only one germ-pore is present in the upper end of each cell, is unique for *Phragmidium*. According to the generic character of *Phragmidium* accepted by such authorities as TULASNE, DIETEL, MAGNUS and LAGERHEIM, the number of the germ-pores are more than two in each cell. DIETEL remarks that the species may belong to the genus *Kuhnicola* which MAGNUS founded on *Ph. albidum* (Kuhn.) Ludw. Yet for the present, we shall retain our species in the genus *Phragmidium*.

5. **Phragmidium Rosæ-multifloræ** Diet., Hedwigia, Bd. 44, 1905, p. 132.

Icon: Dietel, Hedwigia, Bd. 44, 1905, pl. IV. fig. 8.

Hosts and distribution.—

On *Rosa multiflora* Thunb.

Prov. Tosa, Hane-mura (III. T. YOSHINAGA, Oct. 10, 1908)

Prov. Iyo, Gosho-mura (II. K. SENGOKU, June 26, 1900)

„ „ Maruho-mura (III. M. OKUDAIRA, June 15, 1902)

„ „ Misakatōge (II. „ May 20, 1899)

Prov. Bizen, Machikanda (III. I. KONDO, July 20, 1908)

Prov. Musashi, Takao (III. S. KUSANO, Oct. 1899)

Prov. Shimotsuke, Nikkō (III. G. YAMADA et J. HANZAWA, Aug. 6, 1900)

Prov. Echigo, Yahiko (II. III. S. ITO, July 23, 1908)

„ „ Yahagi II. III. „ „ 22, „

„ „ Tsubame II. III. „ „ 26, „

„ „ Gomadō (II. III. „ Aug 20, 1908)

Prov. Rikuchū, Kuzumaki (I. II. III. M. MIURA, July 6, 1907)

Prov. Rikuchū, Iwatezan (II. S. ARIMOTO, July 16, 1903)

Prov. Rikuchu, Asakishi-mura (III. Y. TAKAHASHI, Sept. 26, 1897)

Prov. Rikuchu, Morioka (I. II. G. YAMADA, May 24, 1903)

Prov. Ugo, Sakata (III. G. YAMADA, Aug. 2, 1901)

„ „ Senhoku-gun (I. II. E. TOKUBUCHI, July 12, 1897)

„ „ Akita (II. III. T. YOSHINO, July 1896)

Prov. Mutsu, Goshogawara (III. T. KASHIWAI, Oct. 1904)

Prov. Oshima, Hakodate (III. K. MIYABE, July 10, 1890)

Prov. Ishikari, Sapporo (III. E. TOKUBUCHI, June 28, 1891)

Prov. Ishikari, Sapporo (I. II. III. M. KASAI, June 28, 1908)

Prov. Ishikari, Sapporo (III. M. KASAI, Sept. 24, 1907)

Prov. Ishikari, Makomanai (III. M. KASAI, Nov. 1, 1908)

On *Rosa laevigata* Mich.

Prov. Tosa, Yoshiwaragoe (H. T. YOSHINAGA, Jan. 1908)

REMARKS:— This is also one of the endemic species of *Phragmidium* of our country. This species was erroneously identified to *Ph. subcorticium* (Schrank.) Wint. by DIETEL in 1901 (Engl. bot. Jahrb., Bd. 28, p. 285). The same specimen collected by S. KUSANO at Takao, on which DIETEL made his determination in 1901, is also found in our College Herbarium. An examination of the specimen shows us that it is nothing but *Ph. Rosae-multiflorae* Diet. In Hedwigia, Bd. 44, p. 132, our present species was first described by DIETEL. He mentions there only the name of the collector, S. KUSANO, without giving the locality and the date of the collection. He might have used, as it seems to be the case, the same specimen of 1901 from S. KUSANO over again. The best criterion, by which this species is distinguished from *Ph. subcorticium* (Schrank.) Wint. is its smooth, beautiful, flavated pedicel whose upper half is of a deep yellowish color. The teleutospores make their appearance very early in summer. I got many specimens of them by the end of June last year in the vicinity of Sapporo. This is the only species on *Rosa multiflora* in Hokkaido, as *Ph. japonicum* Diet. has not yet been found here on the same host so far. On *Rosa laevigata* Mich the teleutospores are not yet found. Mr. T. YOSHINAGA informed me, in his letter accompanied to the specimen, that the uredostage on the host above named was identified to *Ph. Rosae-multiflorae* Diet. by DIETEL.

6. **Phragmidium Rosæ-rugosæ.** n. sp.

Caeomata forming a large dense cushion on stems, petioles, and fruits, and on the lower surface of leaves often causing a remarkable deformation, bright orange; paraphyses club-shaped, contents yellow, granular; caeomaspores polygonal or globose, epispore minutely warty, hyaline, contents granular, orange yellow; 22-24 mmm. in diam., germ-pores 3-4.

Uredosori hypophyllous, yellow, minute, orbicular, scattered or crowded; paraphyses linear cylindrical, generally slightly curved; uredospores globose, ovate or polygonal, diameter 16-22 mmm., contents yellow, epispore finely echinulate, 2 mmm. thick, colorless; germ-pores 4-5.

Teleutosori hypophyllous, scattered or loosely aggregated, brown to chestnut-brown, not black, readily detachable; teleutospores cylindrical, rounded at both ends, brownish-yellow; papilla obtuse, very short (4-6 mmm.), yellow; 7-11 celled (some-

times 4-6), 72-128 × 28-32 mmm.; two end cells generally longer (12-16 mmm.) than the rest (8 mmm.); epispores 4-7 mmm. thick, brown, warty; germ-pores 3 in each cell (even in the apical cell); wall of the pedicel pale yellow towards apex, more or less swelled in the basal part, 100-150 mmm. long.

Host and distribution

On *Rosa rugosa* Thunb

Prov. Ishikari, Sapporo (III. K. MIYABE, Oct. 1889)(II. K. MIYABE, July 1892)(I. K. MIYABE, July 1890)(I. II. III. M. KASAI, Oct. 30, 1908)(I. M. KASAI, June 14, 1908)
„ „ Garugawa (III. M. MIURA, Sept. 22, 1907)(II. III. M. KASAI, Oct. 17, 1908)
„ „ Ishikari (III. J. HANZAWA, Oct. 17, 1908)
„ „ Shinoro (III. G. YAMADA, Sept. 23, 1892)
Prov. Oshima, Kamiiso (II. K. MIYABE, July 12 1890)
Prov. Shiribeshi, Okushiri (II. K. MIYABE, July 31, 1980)
„ „ Zenibako (II. III. M. KASAI, Oct. 17, 1908)
Prov. Hidaka, Samani (II. E. TOKUBUCHI, Aug. 9, 1892)
„ „ Niikapp (I. M. KASAI, July 12, 1907)
„ „ Atsubetsu (I. „ „ 9. „)
Prov. Kushiro, Kushiro (II. T. KAWAKAMI, Sept. 1896)
Prov. Nemuro, Nemuro (II. G. SUGIYAMA, Aug. 1891)
Prov. Iburi, Matsushima (II. III. K. MIURA, Sept. 20, 1905)
Rishiri-Island (II. T. KAWAKAMI, Sept. 1, 1899)
„ (II. III. M. MIURA, Aug. 15, 1907)
Rebun-Island (III. M. MIURA, Aug. 24, 1907)
Kurile, Etorofu (I. II. T. KAWAKAMI, Aug. 15, 1898)

REMARKS: – Comparing this with other species of *Phragmidium* already known to grow on *Rosa*, I am disposed to regard it as a new species.

BANDI (1) makes the statement that *Ph. subcorticium* (Schrank.) Wint fails to attack *Rosa rugosa* even when artificially infected. *Rosa arkansana*, *R. blanda*, *R. setigera*, *R. foliosa*, *R. nitida*, *R. Engelmanii*, *R. gymnocarpa*, *R. pisocarpa*, *R. Woodsii*, *R. rubiginosa*, *R. rubrifolia*, and *R. lucida* in the Botanical garden of our College have proved to be perfectly immune to *Phragmidium*, while *Rosa rugosa*, planted near by, is seriously infected by two different species of *Phragmidium*, both of which are peculiar to our country; namely *Ph. Rosae-rugosae* n. sp. and *Ph. yezoense* n. sp. Macroscopically the present species is allied to *Ph. subcorticium* (Schrank.) Wint. with regard to the form of its caeomata and other stages. But in the following points they are at variance.

	Ph. subcorticium.	*Ph. Rosae-rugosae.*
Teleutosori	black	brown.

Teleutospore	brownish-black	yellowish-brown
Number of cells	4–9	7–11
General form	fusiform or subcylindrical	cylindrical
Papilla	long (10-12 mmm.)	very short (4-6 mmm.)
Pedicel	conspicuously bulbous (100-120 mmm. long)	slightly inflated (150 mmm. long)

REMARKS: From *Ph. yezoense* n. sp. this species differs by the colour of its teleutosori as well as by that of the teleutospores. The general form of the teleutospores and the shape of papilla also show sharp points of their dissimilarities. The characteristics of *Ph. Rosae-rugosae* n. sp lie in the very short papilla, a cylindrical outline and also in the brownish-yellow color of its teleutospores. I have often noticed that in the lower part of the pedicel, where fine spiral striation often comes to view, the outer portion of the wall, on a long treatment with potash or water, swells up and melts away leaving the innermost layer of the wall comparatively unchanged.

7. **Phragmidium yezoense** n. sp.

Teleutosori on petioles large, aggregated, often elongated; on the under surface of leaves, small, densely scattered or crowded, black (not brown), readily detachable; teleutospores fusiform, subcylindrical or subclavate, dark-brown, never yellowish-brown, 5-10 celled; attenuated or rounded at both ends, uppermost cell longer than the rest; apical papilla conical or awl-shaped, pale-yellow, generally 6-10 mmm., often rough at its tip; not constricted at septum; 72-108 × 28-32 mmm.; wall thick, verrucose; germ-pores 2-3 in each cell; pedicel pale-yellow in the upper part, more or less bulbous in the lower half (16 mmm. broad), up to 150 mmm. long.

Host and distribution.

On *Rosa rugosa* Thunb.

Prov. Mutsu, Goshogawara (III. T. KASHIWAI, Nov. 1904)
Prov. Iburi, Matsushima (III. K. MIURA, Sept. 20, 1905)
Prov. Shiribeshi, Raidentōge (III. G. YAMADA, Oct. 5, 1900)
„ „ Zenibako (III. M. KASAI, Oct. 17, 1908)
Prov. Ishikari, Sapporo (III. K. MIYABE, Sept. 10, 1895)
„ „ „ (III. M. KASAI, Oct. 30, 1908)
Kurile, Shumushu (III. S. YOKOYAMA, Sept. 22, 1892)
Saghalien, Nayoro (III. T. MIYAKE, Sept. 9, 1906)
„ Pelwayapedji (III. „ Oct. 12. 1906)

REMARKS:— Most probably this is the species that some of our mycologists

have taken to be identical with *Ph. subcorticium* (Schrank.) Wint. BANDI (1) informs us, that *Ph. subcorticium* (Schrank) Schroet. does not inhabit on *Rosa rugosa* which is the host of the species in question. In fact this species differs from the above-named in more than one point. Macroscopically it shows a large and elongated cushion of teleutosori upon the petiole, which, indeed, is neither found nor anywhere mentioned to be seen in the case of *Ph. subcorticium* (Schrank) Wint. Microscopically they disagree not only in the shape and size of the pedicel but also in the nature of the papillum. Taking again the respective number of cells into consideration we frequently come to another point of dissimilarity; for in the case of *Ph. subcorticium* (Schrank.) Wint. there always exist 7 or 8 cells only, while 10 celled form in our species is comparatively often met with. Neither can this species be identical with *Ph. Rosae-sterigerae* Diet. of North America. They differ from each other in the size of the teleutospores, and also in the color of the papilla as well. Distinction between this species and *Ph. americanum* Diet. is also easily noticeable, as we have already discussed in detail under the latter species

On **RUBUS.**

8. **Phragmidium Barnardi** Plowr. et Wint., var. **paucilocular**e Diet., Engl. bot. Jahrb., Bd. 32, 1902, p.49; Diet., Hedwigia, Bd. 44, 1905, p.344; P. Henn., Engl. bot. Jahrb., Bd. 31, 1903, p.732; Sacc., Syll., XVII. p.399; Diet., Ann. Mycol., Bd. 6, 1908, p.227.

Hosts and distribution.

Rubus parvifolius L.

Prov. Iyo, Maruho-mura (II. M. OKUDAIRA, June 17, 1992)
Prov. Tosa, Kamoda-mura (III. T. YOSHINAGA, Nov. 1907)
Prov. Settsu, Kōbe (II. K. MIYABE, Sept. 5, 1889)
Prov. Mino, Ōgaki (II. E. TOKUBUCHI, Dec. 28, 1898)
„ „ Gifu (II. III. „ Oct. 1898)
Prov. Musashi, Ōji (III. K. SENGOKU, Oct. 29 1895)
„ „ Urawa (III. N. NAMBU, Nov. 15, 1899)
Prov. Echigo, Gomadō (II. S. (TO, Aug. 20, 1908)
„ „ Yahagi (II. S. ITO, July 22, 1908)
Prov. Mutsu, Goshogawara (III. T. KASHIWAI, Oct. 1904)
„ „ Furumaki (II. K. SENGOKU, Oct. 4, 1895)
Prov. Iburi, Numanohata (III. K. MIYABE et G. YAMADA, Nov. 1, 1900)
„ „ Oiwake (III. „ „ Oct. 30, 1900)
„ „ Mombetsu (II. K. MIYABE, Aug. 14, 1890)
Prov. Shiribeshi, Zenibako (II. III. K. MIYABE, Oct. 5, 1891)
„ „ (II. III. „ Sept. 9, 1896)

Prov. Shiribeshi, Zenibako (III. G. YAMADA, Oct. 20, 1899)
Prov. Ishikari, Maruyama (I. J. HANZAWA, May 8, 1901)
„ „ „ (III. M. KASAI, Sept. 1), 1908
„ „ „ (I. T. MIYAKE, June 8, 1901)
„ „ Moiwa (III. T. MIYAKE, Oct. 26, 1902)
„ „ Makomanai (III. M. KASAI, Aug. 15, 1907)
„ „ Ishiyama (III. M. KASAI, Sept. 15, 1907)
„ „ Ishikari (III. G. YAMADA, Oct. 24, 1899)
„ „ Asahigawa (III. K. MIURA, Oct. 10, 1906)
„ „ Shimofurano (III. M. KASAI, Sept. 20, 1908)
„ „ Chikabumi (III. T. MIYAKE, Sept. 1905)
„ „ Kamuikotan (III. M. KASAI, Sept. 27, 1908)
„ „ Sapporo (III. K. MIURA, Oct. 30, 1906)(I. K. MIURA, June 5, 1906)(II. E. TOKUBUCHI, Aug. 1895)(I. II. E. TOKUBUCHI, June 30, 1890)(II. III. E. TOKUBUCHI, Sept. 1895)(III. E. TOKUBUCHI, Oct. 1896)(I. K. MIYABE, June 1890)(II. III. K. MIYABE, Oct. 1889)(I. K. MIYABE, June 21, 1892)(II. III. K. MIYABE, Aug. 25, 1891)(III. T. MIYAKE, Oct. 21, 1902)(II. III. M. KASAI, Sept. 13, 1908)(II. III. M. KASAI, Aug. 25, 1907)(III. M. KASAI, Oct. 10, 1907)(III. M. KASAI, Sept. 29, 1907)

On *Rubus phoenicolasius* Maxim.

Prov. Shiribeshi, Zenibako (III. G. YAMADA, Oct. 20, 1899)

REMARKS : – This endemic species was first described by DIETEL in 1903 as a variety of *Ph. Barnardi* Plowr. et Wint., which is an Australian species on *Rubus parvifolius*. But the host of the present variety is not restricted to *Rubus parvifolius* only. For it has been found on *Rubus phoenicolasius*, and is also reported to attack *Rubus rosaefolius* Sm. var. *minor* Hak. As to the *Rubus parvifolius* of Japan, MATSUMURA (20) regards it as synonymous with *Rubus triphyllus*. If it is really so, the Australian host, on which DIETEL lays so much stress in drawing his conclusion, becomes a different thing from the so-called *Rubus parvifolius* of our land. Compared with the description and the photographic figures given by MCALPINE our species appears to vary in divers points from the Australian type, so far as the morphological characters are concerned. All these reasons readily tend us to throw doubts on the correctness of taking this species as a variety of *Ph. Barnardi* Plowr. et Wint. But for the present we shall stick to the present name which is so familiar to us.

9. **Phragmidium griseum** Diet., Engl. bot. Jahrb., Bd. 32, 1903, p.49 ; Sacc., Syll., XVII, p.899 ; Diet., Hedwigia, Bd. 44. 1905, p.344.

Host and distribution

On *Rubus incisus* Thunb.

Prov. Tosa, Kamo-mura (H. III. T. YOSHINAGA, Aug. 15, 1905)
Prov. Kozuke, Myogisan (H. III. S. KUSANO, Nov. 4, 1899
Prov. Shimotsuke, Nikko (H. III. G. YAMADA & J. HANZAWA, Aug. 6, 1900

REMARKS:— This is also one of our endemic species described by DIETEL in 1903. Among the few specimens I have had the occasion to examine, the one received from S. KUSANO may be regarded as the best representative of the type. It has two germ-pores in the uppermost cell of the teleutospore, situated a little above the middle of the cell, while in the other cells there are three set closely under the septum. The general character of the teleutospore bears much resemblance to that of *Ph. Yoshinagai* Diet. DIETEL holds the length, the papillum and the constriction at septum as the distinctive points of their teleutospores. But many well constricted and conically papillated teleutospores of *Ph. Yoshinagai* Diet. have come under my observation which seem to stand in contradiction to DIETEL's remarks to a certain degree.

10. **Phragmidium heterosporum** Diet., Engl. bot. Jahrb., Bd. 22, 1896, p.625; Sacc., Syll., XVII, p.399; Diet., Hedwigia, Bd. 44, 1905, p.344.

Host and distribution.

On *Rubus trifidus* Thunb.

Prov. Tosa, Kōdono (H. T. YOSHINAGA, Jan. 1908)
Prov. Izu, Itō (H. S. KUSANO, Jan. 3, 1900)

REMARKS:— This species is also endemic to our country. The first account of it was given by DIETEL in 1903 after examining the specimen collected by S. KUSANO at Ito, Prov. Izu. The materials I have examined were all in the uredostage. DIETEL made remarks concerning the affinity of this species with *Ph. obtusum* (Strauss) Wint. I have, however, hardly, any thing to say on this species, as I have not been able to observe the teleutospores myself.

11. **Phragmidium Nambuanum** Diet., Ann. Mycol., Bd. VI, 1908, p.227.

Host and distribution.

On *Rubus occidentalis* L. var. *japonica* Miyabe.

Prov. Iburi, Eniwasan (H. III. K. MIYABE et S. ARIMOTO, Aug. 6, 1902)
Prov. Ishikari, Moiwa (III. G. YAMADA, Oct. 17, 1897)
" " " (H. III. K. MIYABE, Oct. 19, 1803)
" " " (H. III. " Oct. 11, 1901)
" " " (III. " Nov. 3, 1897)

REMARKS:— This species is also one of our endemic forms of *Phragmidium*,

recently described by DIETEL. The teleutosori resemble those of *Ph. Rubi-Idaei* (Pers.) Wint. on *Rubus Idaeus* var. *strigosus*. But under the microscope *Ph. Nambuanum* Diet. will at once be distinguished by its characteristic broad, stout and cylindrical teleutospores, conspicuous for the absence of papillum. This fungus is comparatively common in the vicinity of Sapporo.

12. **Phragmidium Rubi** Pers., Wint., Pilze, p.230; Sacc. Syll., VII. p.745; Schroet., Pilze Schles., p.353; Plowr., British Ured. and Ustilag., p.224; Fischer, Ured. Schweiz, p.418; Tubeuf, Handb., p.375; Klebahn, Zeits. f. Pflanzenkr., Bd. 17, 1907, p.140–142.

Icon.: Fischer, Ured. d. Schweiz, p.418, fig.290; Plowr., British Ured. and Ustilag., pl. VI, fig.5; Tubeuf, Handb., p.375. fig.173; Ludwig, Lehrb. d. Kryptogamen, p.475. fig.16.

Host and distribution.

On *Rubus arcticus* L.

Saghalien, Kusunnai (III. T. MIYAKE, Sept. 8, 1907)
„ Shikka (III. „ Aug. 20, 1906)
„ Solowiyohuka (III „ Sept. 20, 1907)

REMARKS:— This species is a new addition to our flora. *Rubus arcticus* L. seems to be a new host for this fungus. *Uredo arctica*, recorded by LAGERHEIM (15) as living on the same host plant, appears to have no connection whatsoever with our present *Phragmidium*. The number of cells, a sharp papillum and shorter pedicel are the characters which distinguish *Ph. Rubi* (Pers.) Wint. from *Ph. Rubi-Idaei* (Pers.) Wint. and *Ph. Rubi-japonici* n. sp. So far as our present knowledge is concerned, this species is found in Japan only in the Saghalien Island.

13. **Phragmidium Rubi-Idaei** (Pers.) Wint., Die Pilze, p.231; Sacc., Syll., VII, p.448; Fischer, Ured. Schweiz, p.420; Schroet., Pilze Schles., p.353; Plowr., British Ured. and Ustilag., p.226; Klebahn, Zeits. für Pflanzenkr., Bd. 17, 1907, p.141-142.

Icon: Dietel, Engl. u. Plantl, Pflanzenfam., 1. 1. p.71. fig.47. D; Fischer, Ured. d. Schweiz, p.420. fig.291; Ludwig, Lehrb. d. Kryptogamen, p. 475. fig.15.

Host and distribution.

On *Rubus Idaeus* L. var. *strigosus* Maxim.

Kurile, Kunashiri, Zembekotan (III. H. TANAKA, Aug. 1893

Prov. Ishikari, Jozankei (III. G. YAMADA, Oct. 12, 1902)
" " Moiwa (H. III. T. MIYAKE, Oct. 4, 1903)
" " Misomai (III. K. MIYABE, Oct. 11, 1905)
" " Misomai (III. J. HANZAWA, Oct. 11, 1905
" " Ishiyama (III. " " "

REMARKS: — This is also one of the species newly added to our flora. The fungus is comparatively abundant in the vicinity of Sapporo. Comparing our plant to the North American specimens of *Ph. Rubi-Idaei* (Pers.) Wint. preserved in our College Herbarium there remains hardly any doubt as to their identity. *Ph. Rubi-Idaei* (Pers.) Wint. differs from *Ph. Rubi* (Pers.) Wint. by the number of the cells and by the shape of the papillum of the teleutospores. Also in spite of the many apparent similarities existing between this species and *Ph. Rubi-japonici* n. sp., they differ from each other in the length of the pedicel, and also in the form of the uppermost cell.

14. **Phragmidium Rubi-japonici** n. sp.

Teleutosori hypophyllous, scattered, pulverulent, loose and black; teleutospores subcylindrical, 6-11 celled, 72-120×24-28 mmm., tapering or rounded at apex, papillum acute, base rounded, not constricted at septum, uppermost cell longer than the rest; epispore thick, dark-brown, verrucose; germ-pores 3 or 4 in each cell; pedicel shorter than or same as the spore-length, 59-110 mmm., flavate at the base and yellowish in the upper part.

Host and distribution.

On *Rubus japonicus* Maxim.

Prov. Ishikari, Jozankei (III. G. YAMADA, Oct. 12, 1902)
" " " (III. M. MIURA, Oct. 17, 1909)
" " " (III. T. MIYAKE, Oct. 17, 1909)

REMARKS:— The fungus under consideration was at first taken to be identical with *Ph. Rubi-Idaei* (Pers.) Wint. But after all we are rather inclined to regard it as a new species. Our present type is easily distinguished from *Ph. Rubi-Idaei* (Pers.) Wint. by the shorter pedicel and also by the acute papillum of its teleutospore. Besides *Rubus japonicus*, being herbaceous, varies widely in its habit from *Rubus Idaeus* var. *strigosus*.

15. **Phragmidium Rubi-Thunbergii** Kusano, Tokyo Bot. Mag., Vol. 18, 1904, p.147; Diet., Engl. bot. Jahrb., Bd. 37, 1905, p.104; Diet., Hedwigia, Bd. 44, 1905, p.344.

Host and distribution.

On *Rubus Thunbergii* S. et Z.

Prov. Iyo, Iwayama (H. M. OKUDAIRA, May 21, 1899.)
Prov. Settsu, Kōbe (H. K. MIYABE, Sept. 5, 1889)
Prov. Sagami, Hakone (H. K. MIYABE et G. YAMADA, April 12, 1901
„ „ „ (H. K. MIYABE, April 12, 1901)
„ „ „ (H. N. HIRATSUKA, Aug. 2, 1898)
Prov. Musashi, Tōkyō (H. S. HORI, April 17, 1900)
„ „ „ (H. M. SHIRAI, Nov. 1905)
„ „ Hachioji (H. Y. TAKAHASHI, July 27, 1893)

REMARKS:— This species is also endemic to our country. KUSANO's original description is said to have reached DIETEL, while his paper on *Phragmidium* in 1905 was in the press. However, DIETEL made a short remark on this species under *Ph. Rubi* (Pers.) Wint. var. *miniatum* J. Müll., saying "Als eine neue, in dieser Arbeit noch nicht berücksichigte Art erhielten wir während des Druckes noch *Ph. Rubi-Thunbergii* Kusano auf *Rubus Thunbergii* S. et Z. aus Japan. Sie ist den anderen japanischen Art sehr ähnlich". But nobody will think, that the present species is allied to *Ph. Rubi* (Pers.) Wint. var. *miniatum* J. Müll., when he once observed the smooth epispore of the former. In reality, the smoothness of the epispore of *Ph. Rubi-Thunbergii* Kusano was not mentioned in the original description of this species. Through the kindness of Prof. M. SHIRAI I got a specimen of the teleutostage of the present species. Under the microscope the teleutospore disclosed its resemblance to *Ph. griseum* Diet. in the character of the papillated apex and of the constriction at septum. But, as the author of the species well noticed in his remarks, the number of the germ-pores in each cell are 2, while in the case of *Ph. griseum* they are generally 3. The length of the pedicel of the present species is also always shorter than that of *Ph. griseum*.

16. **Phragmidium Yoshinagai** Diet., Engl. bot. Jahrb., Bd. 34, 1905, p.586; Diet., Engl. bot. Jahrb., Bd. 37, 1905, p.104; Diet., Ann. Mycol., Vol. VI, 1908, p.227; P. Hennings, Engl. bot. Jahrb., Bd. 34, 1905, p.596.

Hosts and distribution.

On *Rubus morifolius* Sieb.

Prov. Tosa, Imai (H. T. YOSHINAGA, Oct. 4, 1903)

On *Rubus crataegifolius* Bge.

Prov. Iwaki, Tōgatta (H. H. K. MIYABE, Aug. 28, 1893)
Prov. Iwate, Asakishi-mura (H. H. Y. TAKAHASHI, Sept. 26, 1897)

Prov. Rikuchu, Tsunagi-mura (III. Y. TAKAHASHI, June 17, 1897)
Prov. Mutsu, Hirosaki (III. N. HIRATSUKA, Sept. 29, 1897)
Prov. Oshima, Nanae-mura (III. T. MIYAKE, Aug. 11, 1897)
„ „ Hakodate (III. K. MIYABE, July 10, 1890)
Prov. Shiribeshi, Kumaishi (III. „ „ 25, 1890)
„ „ Otaru (III. G. YAMADA, Aug. 1898)
„ „ „ (III. T. KAWAKAMI, Oct. 1898)

REMARKS:— Mr. T. YOSHINAGA kindly sent me, on request, a part of the type specimen on *Rubus morifolius*, with which I was able to compare our Hokkaido forms on *Rubus crataegifolius*. On examination I came to know that they are doubtlessly the same as *Ph. Yoshinagai* Diet. Only point of difference is that 6-celled teleutospores are comparatively often encountered in the case of the Hokkaido-forms, while in the Tosa specimen the spores are always composed of less than five cells.

On **SANGUISORBA.**

17. **Phragmidium carbonarium** (Schlechts.) Wint., Die Pilze, p.227; Fischer, Ured. d. Schweiz, p.406; Sacc., Syll., VII, p.751; Plowr., British Ured. and Ustilag., p.227; Schroet., Pilze Schles., p.355; Dietel, Engl. bot. Jahrb., Bd. 27, 1900, p.567; Dietel, Hedwigia, Bd. 44, p.346; P. Hennings, Engl. bot. Jahrb., Bd. 27, p.147.

Icon.: Fischer, Die Ured. d. Schweiz, p.407, fig.284; Dietel, Engl. u. Plantl, Pflanzenfam., 1. 1. p.71. fig.47. E; Ludwig, Lehrb. d. Kryptogamen, p.475. fig.22.

Hosts and distribution.

On *Sanguisorba tenuifolia* Fisch. var. *alba* Trautv. et Mey.

Prov. Shinano, Yatsugadake (III. T. MIYAKE, Aug. 5, 1903)
Prov. Ishikari, Kita-mura (I. K. MIURA, May 24, 1906)
„ „ Sapporo (I. „ „ 26, 1906)
„ „ Horomui (I. G. YAMADA, July 3, 1902)(I. III. G. YAMADA, July 30, 1900)(I. III. S. ITO, July 8, 1908)
„ „ Fukagawa (I. III. T. MIYAKE, July 10, 1901)
„ „ Sarugawa (I. III. K. MIYABE, July 9, 1891)
„ „ Tobetsu (I. I. SHIMIZU, July 21, 1890)
„ „ Tsuishikari (I. III. S. ITO, July 1907)
Prov. Oshima, Hakodate (III. K. MIYABE, July 10, 1894)
„ „ Izumizawa (III. „ „ 13, 1890)
„ „ Kamiiso (III. „ „ 12 1890)

Prov. Hidaka, Samani (III. Y. TOKUBUCHI, Aug. 8, 1892)
„ „ Numanohata (I. III. M. KASAI, July 7, 1907)
„ „ Niikapp (I. III. „ „ 20, 1907)
Prov. Iburi, Oshamambe (I. G. YAMADA, July 26, 1807)
„ „ Mororan (I. K. MIYABE, June 10, 1900)
„ „ „ (III. G. YAMADA, Aug. 3, 1898)
Rishiri Island, Oshitomari (III. T. KAWAKAMI, July 21, 1899)
Kurile Island, Etrofu, Shana (I. K. MIURA, July 11, 1906)
„ „ „ Toro (I. „ „ 24, 1906)
„ „ Shakotan (III. T. KAWAKAMI, Aug. 1, 1898)
„ „ Etrofu, Shana (III. „ „ 3, 1898)

On *Sanguisorba officinalis* L.

Prov. Musashi, Tōkyō (III. S. KUSANO, May 30, 1897)
Prov. Shimotsuke, Nikkō (I. III. G. YAMADA et J. HANZAWA, Aug. 6, 1900)
Prov. Rikuchu, Morioka (III. S. ARIMOTO, July 15, 1903)

On *Sanguisorba canadensis* L. var. *media* Maxim.

Prov. Ugo, Chōkaizan (I. K. MIURA, Aug. 28, 1905)
Prov. Uzen, Gwassan (III. „ „ 13, 1905)
„ „ „ (III. G. YAMADA, Aug. 7, 1601)
Prov. Iwaki, Zuwozan (III. K. MIYABE, Aug. 29, 1893)
Prov. Rikuchu, Iwatesan (III. „ Sept. 4, 1893)
Kurile Island, Urup (I. K. MIURA, July 8, 1905)

REMARKS:— This fungus is very common in northern Japan.

CONCLUSION.

In the preceeding pages it has been my endeavour to enumerate the seventeen species of *Phragmidium* found in Japan. These embrace ten species hitherto found in our country, four that have been unknown to us up to this day, and three that appear to be quite new to science. Among these seventeen species eleven are found only in this country.

Though proper justice has been done in their respective places, it seems worth while to discuss briefly how the mistake with regard to the identification of *Ph. subcorticium* (Schrank.) Wint. and *Ph. Fragariastri* (DC.) Schrœt. occurred.

Originally *Ph. subcorticium* (Schrank.) Schrœt. was a European species. It was subsequently introduced into America and Australia. So far as our knowledge goes this species is not found at all in our country. It is true that reference to it is found in all our writings on this genus. But of these writings one of DIETEL is the earliest and practically the basis of all subsequent works. It has been my

good fortune to get from the College Herbarium the very specimen (No. 92) collected by Prof S. KUSANO at Mt. Takao, Prov. Musashi, on June 11, 1899, which DIETEL reported upon as *Ph. subcorticium* (Schrank.) Wint. in 1901. Under the microscope the above mentioned specimen showed to be nothing but *Ph. Rosae-multiflorae* Diet. At the time of describing *Ph. Rosae-multiflorae* Diet. in 1905, DIETEL did not give us the date and locality for the specimen, on which he founded this new species. He only mentioned KUSANO, the collector's name. This fact makes it probable, that DIETEL used the same specimen in both occasions.

As regards the existence of *Ph. Fragariastri* (DC.) Schroet. in Japan, frequent references are met with in our literature. Both kinds of specimens on which P. HENNINGS made his report have been also in our possession While I was engaged in the study of these specimens they appeared to us upon examination to differ in no way from *Puccimiastrum Potentillae* Kom. This fact drew us on to a further study and closer examination of the above named *Puccimiastrum*. In the course of my study my attention was directed to DIETEL's remark under *Puccimiastrum Potentillae* Kom., in his Uredineen Japonicae VI. (p.105), where he clearly sets down as follows; namely "Es ist dies Pilz *(Puccimiastrum Potentillae Kom.)*, der von P. HENNINGS in Fungi japonici IV als *Ph. Fragariastri* (DC.) Schroet. aufgeführt ist." This remark of DIETEL fully agrees with and corroborates what I had found to be the fact. Under *Ph. Potentillae* (Pers.) Karst., I have already said that in our country *Ph. Fragariastri* (DC.) Schroet. has not yet been found.

HOST-INDEX.

1. **Potentilla** L.

Potentilla chinensis Ser. ..... *Phragmidium Potentillae* (Pers.) Karst.
Potentilla cryptotaeniae Maxim. ..... ,,
Potentilla Dickinsii Er. et Sav. ..... ,,
Potentilla gelida C. A. Mey. ..... ,,
Potentilla Kleiniana W. et A. ..... ,,

2. **Rosa** Tourn.

Rosa acicularis Lindl. ..... *Phragmidium fusiforme* Schroet.
Rosa dahurica Pall. ..... *Ph. americanum* (Pk.) Diet.
Rosa laevigata Mich. ..... *Ph. Rosae-multiflorae* Diet.
Rosa luciae Pr. et Roch. ..... *Ph. japonicum* Diet.

Rosa multiflora Thunb.	*Ph. japonicum* Diet.
„	*Ph. Rosae-multiflorae* Diet.
Rosa rugosa Thunb.	*Ph. Rosae-rugosae* n. sp.
„	*Ph. yezoense* n. sp.
Rosa Wichuriana Crep.	*Ph. japonicum* Diet.

3. **Rubus** L.

Rubus arcticus L.	*Phragmidium Rubi* (Pers.) Wint.
Rubus crataegifolius Bge.	*Ph. Yoshinagai* Diet.
Rubus Idaeus L. var. *strigosus.*	*Ph. Rubi-Idaei* (Pers.) Wint.
Rubus incisus Thunb.	*Ph. griseum* Diet.
Rubus japonicus Maxim.	*Ph. Rubi-japonici* n. sp.
Rubus morifolius Sieb.	*Ph. Yoshinagai* Diet.
Rubus occidentalis L. var. *japonicus.*	*Ph. Nambuanum* Diet.
Rubus parvifolius L.	*Ph. Barnardi* var. *pauciloculare* Diet.
Rubus phoenicolasius Maxim.	„
Rubus Thunbergii S. et Z.	*Ph. Rubi-Thunbergii* Kusano.
Rubus rosaefolius Sm. var. *minor.*	*Ph. Barnardi* var. *pauciloculare* Diet.
Rubus trifidus Thunb.	*Ph. heterosporum* Diet.

4. **Sanguisorba** L.

Sanguisorba canadensis L. var. *media.*	*Ph. carbonarium* (Schlecht.) Wint.
Sanguisorba officinalis L.	„
Sanguisorba tenuifolia Fisch. var. *alba.*	„

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24. **Scribner, F.L.** Report of the Chief of the Section of Vegetable Pathology. 1888,

p.369-372.

25. **Sydow, H. et P. & Butler E. J.** Fungi Indiæ orientalis Pars II. Ann. Mycol., Bd. 5, 1907. S. 485-515.)

26. **Thümen, F. Von.** Beiträge zur Pilz-Flora Sibiriens.

EXPLANATION OF FIGURES IN PLATE I.

All the figures were drawn with the aid of a camera-lucida, magnification being about 390 times. *Ph. heterosporum* Diet. is not included being unable to get the teleutospore of the same.

Fig. 1. *Phragmidium Potentillae* (Pers.) Karst.
Fig. 2. *Phragmidium americanum* (Ph.) Diet.
Fig. 3. *Phragmidium fusiforme* Schrœter.
Fig. 4. *Phragmidium japonicum* Diet.
Fig. 5. *Phragmidium Rosae-multiflorae* Diet.
Fig. 6. *Phragmidium Rosae-rugosae* n. sp.
Fig. 7. *Phragmidium yezoense* n. sp.
Fig. 8. *Phragmidium Barnardi* Plower. et Wint. var. *pauciloculare* Diet.
Fig. 9. *Phragmidium griseum* Diet.
Fig.10. *Phragmidium Nambuanum* Diet.
Fig.11. *Phragmidium Rubi* (Pers.) Wint.
Fig.12. *Phragmidium Rubi-Idaei* (Pers.) Wint.
Fig.13. *Phragmidium Rubi-japonici* n. sp.
Fig.14. *Phragmidium Rubi-Thunbergii* Kusano.
Fig.15. *Phragmidium Yoshinagai.* Diet.
Fig.16. *Phragmidium carbonarium* (Schlecht.) Wint.

摘　　要

一千九百〇五年**Dietel**氏は Hedwigia 誌上に於て *Phragmidium* に就き精細なる論文を公にし内に四十六種を記載せり。其後諸學者の研究に依りて發表せられたる種類は略八種に止まるが如し、故に

全世界に於て知られたる本屬菌類の全數は五十四種と計上するを得べし。今之れを文献に徴するに本邦に産するものは其内僅かに十二種に過ぎず。即ち *Ph. Potentillae* (Pers.) Karst., *Ph. Fragariastri* (DC.) Schroet., *Ph. japonicum* Diet., *Ph. Rosa-multiflorae* Diet., *Ph. subcorticium* (Schrank.) Wint., *Ph. Barnardi* Plowr. et Wint. var. *paucilocculare* Diet, *Ph. griseum* Diet., *Ph. heterosporum* Diet., *Ph. Nambuanum* Diet., *Ph. Yoshinagai* Diet., *Ph. Rubi-Thunbergii* Kusano, 及び *Ph. carbonarium* (Schlecht.) Wint. なりとす。然れ共余が今回の研究に依れば以上列記せるものの内 *Ph. Fragariastri* (DC.) Schroet., 及び *Ph. subcorticium* (Schrank.) Wint. の二種は全く本邦に於て産せざるものたり。

抑々 *Ph. Fragariastri* の本邦所産菌類として認めらるゝに至りしは一千九百〇二年 **P. Hennings** 氏が Engler's botanisches Jahrbücher 誌上に公にせる Fungi Japonici IV. 中に本種を記せしに始まる。然るに今余は曾つて同氏が其論文を草するに當つて親しく檢索せられたる該標品を檢鏡するに之れ全く *Pucciniastrum Potentillae* Kom. の寄生せるものに過ぎざりき。尚此點に關して **Dietel** 氏は曾つて同誌上に於て **P. Hennings** 氏の誤謬たるを指摘せるものあり。之れを要するに本邦に於ける *Potentilla* 屬の植物に寄生する *Phragmidium* は只 *Ph. Potentillae* (Pers.) の一種あるのみ。

次に *Ph. subcorticium* は草野氏が武藏國高尾に於て採集せられたるのいばらの葉上に寄生せる *Phragmidium* の標品に基きて一千九百〇一年 **Dietel** 氏が本種と同一種なりとし Engl. bot. Jahrb. 誌上に發表せるを嚆矢とし爾來本邦菌學家はのいばらの外はまなすに寄生せるものをも該名稱の下に置きたるものなり。今 **Dietel** 氏の所謂 *Ph. subcorticium* を草野氏の採集に係る原標品によりて檢するに一千九百〇五年 **Dietel** 氏が新種として記載せる *Ph. Rosae-multiflorae* と符節を合するが如く秋毫の差違を認めず。而して同著者は該新種を記載す

るに當つて何等此處に論及せざるのみならず其採集地及び採集月日をも記入せず只草野氏の採集品たるを示すに止まる。之に依つて或は同一標品を用ゐて記載せるものにあらざるやを疑ふものなり。次にはまなすに寄生せる *Phragmidium* は精細に觀察する時は種々の點に於て相違し到底之れと同一種なりと認むること能はず。而して尙其葉上に寄生するものと梢上に寄生するものとは其形態大に異るを以て余は前者を *Ph. Rosa-rugosæ*, 後者を *Ph. yezoense* と命名せり。

以上述ぶる理由に依りて此等二種を本邦菌界より除去すれば已知本邦産 *Phragmidium* の種類は只十を數ふるのみ。而して今回余の考察によりて尙此れに七種を添加することを得たり。內三種は新種と認識し新に之れを記載せり。今其添加七種の名稱を記すれば *Ph. americanum* (Pk.) Diet., *Ph. fusiforme* Schroet., *Ph. Rubi* (Pers.) Wint., *Ph. Rubi-Idaei* (Pers.) Wint., *Ph. Rosæ-rugosæ* n. sp., *Ph. yezoense* n. sp. 及び *Ph. Rubi-japonici* n. sp. なりとす。

前記の種類を通算せば其數は實に十七種となる。內本邦特種と認むべき種類は *Ph. japonicum* Diet., *Ph. Rosæ-multifloræ* Diet., *Ph. Barnardi* Plowr. et Wint. var. *pauciloculare* Diet., *Ph. griseum* Diet., *Ph. heterosporum* Diet., *Ph. Nambuanum* Diet., *Ph. Yoshinagai* Diet., *Ph. Rubi-Thunbergii* Kusano, *Ph. Rosæ-rugosæ* n. sp., *Ph. yezoense* n. sp. 及び *Ph. Rubi-japonici* n. sp. の十一種とす。

終りに臨んて本邦に於ける此等菌類の寄主植物を記すれば次の如し。

1. **Potentilla** L.

Phragmidium Potentillæ (Pers.) Karst.

Potentilla chinensis Ser. カハラサイゴ

„ *Cryptotaenice* Maxim. ミツモト

„ *Dickinsii* Fr. et Sav. イハキンバイ

„ *gelida* C. A. Mey. ミヤマキンバイ

Potentilla Kleiniana W. et A. ヲヘビイチゴ

2. **Rosa** Tourn.

Phragmidium americanum (Pk.) Diet.

Rosa dahurica Pall. カラフトバラ

Ph. fusiforme Schrœt.

Rosa acicularis Lindl. タカネバラ

Ph. japonicum Diet.

Rosa Lucia Fr. et Roch. ハヒイバラ

„ *multiflora* Thunb. ノイバラ

„ *Wichuriana* Crep. テリハノイバラ

Ph. Rosae-multiflorae Diet.

Rosa laevigata Mich. ナニハイバラ

„ *multiflora* Thunb. ノイバラ

Ph. Rosae-rugosae n. sp.

Rosa rugosa Thunb. ハマナス

Ph. yezoense n. sp.

Rosa rugosa Thunb. ハマナス

3. **Rubus**. L.

Phragmidium Barnardi Plowr. et Wint. var. *paucilveulare* Diet.

Rubus parvifolius L. ナハシロイチゴ

„ *phoenicolasius* Maxim. ウラジロイチゴ

„ *rosaefolius* Sm. var. *minor* Hack. バライチゴ

Ph. griseum Diet.

Rubus incisus Thunb. ニガイチゴ

Ph. heterosporum Diet.

Rubus trifidus Thunb. カヂイチゴ

Ph. Nambuanum Diet.

Rubus occidentalis L. var *japonicus* Miyabe. クロイチゴ

Ph. Rubi (Pers.) Wint.

Rubus arcticus L. チシマイチゴ

Ph. Rubi-Idaei (Pers.) Wint.

Rubus Idaeus L. var. *strigosus* Maxim. エゾイチゴ

Ph. Rubi-japonici n. sp.

Rubus japonicus Maxim. ゴエフイチゴ

Ph. Rubi-Thunbergii Diet.

Rubus Thunbergii S. et Z. クサイチゴ

Ph. Yoshinagai Diet.

Rubus crataegifolius Bge. タチイチゴ

Rubus morifolius Sieb. クマイチゴ

4. **Sanguisorba** L.

Phragmidium carbonarium (Schlecht.) Wint.

Sanguisorba canadensis L. var. *media* Maxim

ウスベニワレモカウ

„ *officinalis* L. ワレモカウ

„ *tenuifolia* Fisch. var. *alba* Trautv. et Mey.

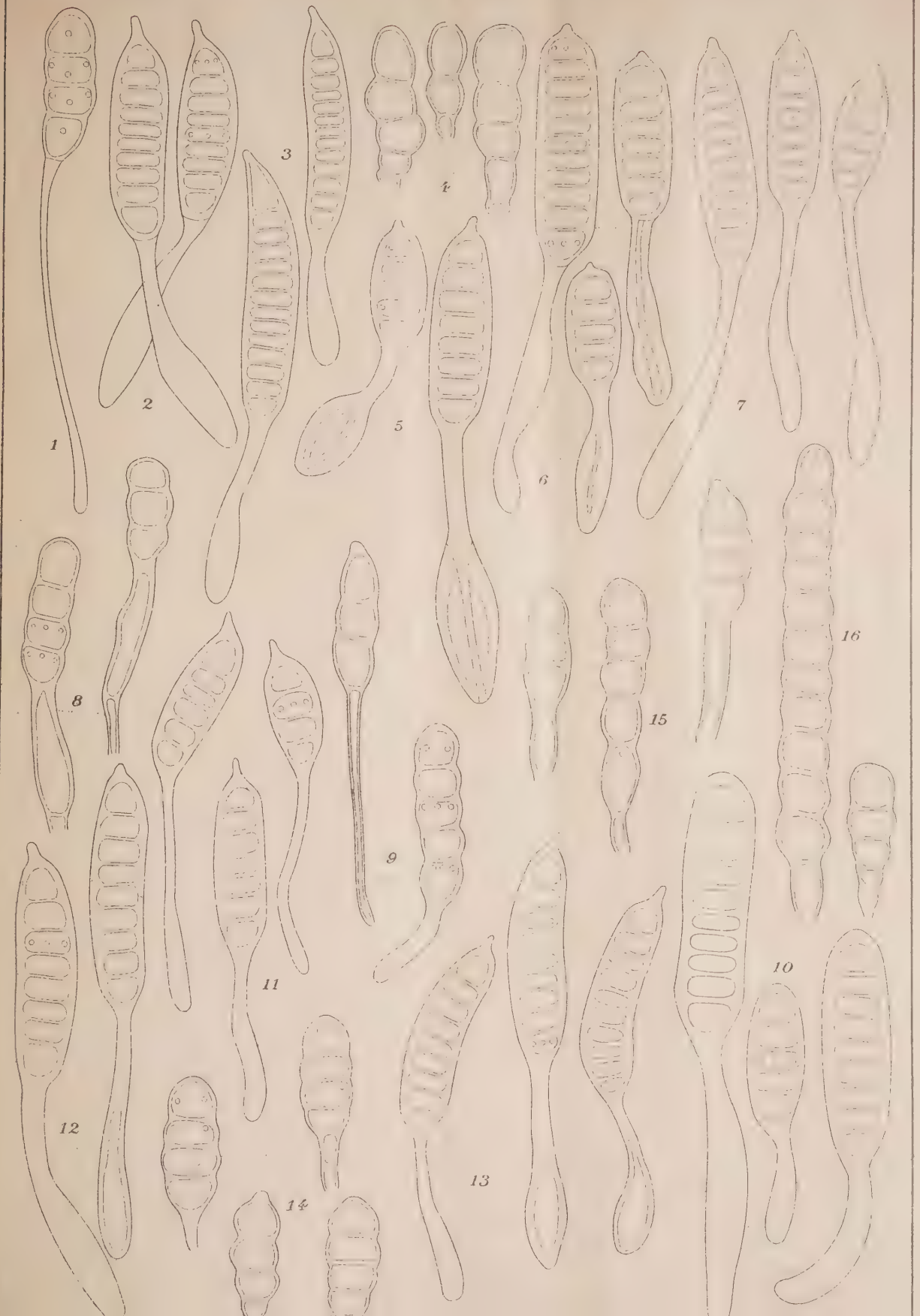
シロワレモカウ

終りに臨んで本研究をなすに當つて恩師宮部博士の常に懇篤なる指導を與へられ且つ當農科大學植物學教室所藏の本屬菌の標本を檢閲することを快認せられたることを深謝すると共に余の需によりて貴重なる標品を惠與せられたる白井教授、草野助教授、三宅學士並に吉永氏に向つて謹んで其好意を謝し併せて種々の點に就き助言と助力とを與へられたる高橋、伊藤兩學士に對して感謝の意を表す。 (明治四十二年十一月稿)

附記、日本菌類志料とは東北帝國大學農科大學教授理學博士宮部金吾氏の研究並に氏の指導によりてなれる本邦產菌類の研究結果を輯むるものにして已に發表せられたるもの次の如し。

1. T. MIYAKE, On Puccinia Parasitic on the Umbelliferæ of Japan. Journ. of the Sapporo Agric. Coll. Vol. II. Pt. 3. 1906.

2. S. ITO, On the Uredineæ Parasitic on the Japanese Gramineæ. Journ. of the Coll. of Agric. Tohoku Imp. Univ. Sapporo. Vol. III. Pt. 2. 1909.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Journal of the Sapporo Agricultural College Vol III 1909

CONTRIBUTIONS TO THE MYCOLOGICAL FLORA OF JAPAN. II.[1]

On the Uredineae Parasitic on the Japanese Gramineae.

By

Seiya Itō, *Nōgakushi.*

(With Plates X– XII)

INTRODUCTION.

The annual loss owing to the rust of cereals is often quite enormous. In Europe and America, the disease has consequently attracted a good deal of attention from old times.

In 1864-'65 DE BARY (1) proved scientifically for the first time the genetic relation between *Puccinia graminis* Pers., and *Æcidium Berberidis* Gmel. The discovery of the heteræcism in the cereal rusts may be regarded as the starting point in the history of the scientific investigations of the rust-fungi. In 1896, J. ERIKSSON with his assistant E. HENNING published "Die Getreideroste," which is regarded as a classical work on the subject in question. The appearance of this great work has stimulated the investigation on the same subject by botanists in many countries. Their attention has especially been turned to biological questions. Among the investigators on the subject, the name of P. DIETEL, E. FISCHER, Fr. BUBÁK, T. SOFPITT, P. SYDOW, W. TRANZCHEL, MARSHALL WARD, H. KLEBAHN and A. CARLETON are never to be forgotten by the students of Phytopathology. Recently, POLE EVANS(1) has contributed the idea, that many biological species can also be recognized by their cytological characters. On the other hand, the study of the sexual processes in the Uredineae has made a remarkable progress for the last four or five years. And the relation of the cereal rust to

(1) Prepared under the direction of Prof. Dr. K. MIYABE.
Contributions. I.—T. MIYAKE, On Puccinia Parasitic on the Umbelliferae of Japan. Journ. of the Sapporo Agric. Coll. Vol. II. Pt. 3. 1906.

climate has also been studied by many scholars. Moreover, the question of the propagation of the rust fungi has been fully discussed by ERIKSSON, MARSHALL WARD, KLEBAHN and other botanists.

In our country, very little has as yet been done in regard to the investigations of the biological characters as well as of the preventive means of the rust fungi. But to carry out such investigations satisfactorily, the classification based on careful morphological studies must first be undertaken.

Messrs. Y. TAKAHASHI (1)(2) and A. MABE (1) made some systematic studies of the rust fungi of our cereals. Mr. S. HORI (1)(2) published the result of his study on *Puccinia corticioides* Berk. et Br., Mr. K. YOSHINO (1) on the rust of *Setaria italica* Beauv. var. *germanica* Trin., and recently Prof. S. KUSANO (2) published a monograph of Puccinia on the leaves of Bambuseae, in which he described two new species, *Puccinia Phyllostachydis* and *Puccinia Sasae*, and a new variety, *Puccinia Kusanoi* Diet. var. *Azuma*. Besides those works, there are none yet published in our country relating to the Uredineae on Gramineae. Most of our species were identified and described by European mycologists—BERKELEY, DIETEL, SYDOW, P. HENNINGS and MAGNUS.

A large number of the specimens of the Uredineae on the Japanese grasses preserved in the Herbarium of our University were kindly placed in my hand by Prof. K. MIYABE for the preparation of the present paper. Besides them, many interesting and valuable specimens were kindly sent at my request by Profs. M. SHIRAI, S. KUSANO and G. YAMADA, Messrs. Y. TAKAHASHI, A. IDETA, T. NISHIDA, T. KAWAKAMI, J. HANZAWA, T. MIYAKE, R. SUZUKI, M. MIURA, M. KASAI, N. NAMBU, K. YOSHINO, T. YOSHINAGA and T. KURIHARA. All these specimens are now preserved in our University Herbarium.

The specimens have been collected from different parts of Japan, from Saghalien and Kurile Islands on the north, to Formosa on the south. The total number of specimens I have examined is about 800, in which six genera, 73 species and 2 varieties are included. They are as follows:—Uromyces 4 sps., and 1 var., Puccinia 58 sps., and 1 var., Diorchidium 1 sps., Stereostratum 1 sps., Rostrupia 2 sps., and Uredo 7 sps.

Among these species, those which are newly added to the Japanese mycological flora are 28 species and 1 variety, those which seem to me as entirely new and are described as such in this paper are 21 species and 1 variety; and 39 species and 2 varieties are endemic to Japan.

I wish to express here my heartiest thanks to Prof. Dr. K. MIYABE to whom I am indebted for his many valuable suggestions and his constant kind direction. To the gentlemen, above mentioned, who have kindly helped me by sending valuable and interesting specimens, I express my sincere thanks. I wish also to acknowledge my indebtedness to Messrs. Y. TAKAHASHI, J. HANZAWA and T. MIYAKE, who have kindly helped me in many ways.

SPECIAL PART.

UROMYCES Link.

A. Teleutospores provided with coronate apex.

1. Uromyces ovalis Diet. in Engl., Bot. Jahrb., **37**, 1905, (97).—(Pl. X. Fig. 1.)

Hab. On *Leersia oryzoides* Sw. var. *japonica* Hack.

Honshū.—Prov. Musashi: Kami-Itabashi (II. & III. Oct. 29, 1904. S. KUSANO).

Distrib. Japan.

REMARKS. I was fortunate enough to examine the original specimen of this species by the kindness of Prof. S. KUSANO, and that is the only specimen, I have examined.

In 1905, DIETEL (9) noted the affinity of this species to *Uromyces Halstedii* De Toni of North America. He remarked that it is hard to distinguish our species by uredospores only from *Uromyces Halstedii*. But in the case of teleutospores, their difference is evident. In *Uromyces Halstedii*, the paraphyses are hyaline, the teleutospore wedge-shaped at base, and broadly truncate at apex; the general shape is triangular, and it is larger in measurement; and the pedicel is shorter; while in *Uromyces ovalis*, the paraphyses are light brown, the teleutospore rounded or attenuated at base and rounded at apex, the general shape being spherical obovate or obovate,

the size smaller ($18-30 \times 13-19\,\mu$) and the pedicel as long as the spore or sometimes longer.

2. **Uromyces coronatus** Miyabe et Nishida. Diet., Bot. Centralb., 105, 1907, (494).—(Pl. X. Fig. 2.)

Syn.: *Uromyces coronatus* Yoshinaga. Diet., in Ann. Mycol., 5, 1907, (70).

Hab. On *Zizania aquatica* L.

Honshū.—Prov. Musashi: Akabane (III. Oct. 22, 1902. K. Yoshino); Komaba (II. July 16, 1906. T. Karashima).—Prov. Echigo: Yoshikawa-mura (II. July 24, 1903. K. Yoshino).

Shikoku.—Prov. Tosa: Ushioe-mura (II. & III. Oct. 1906. T. Yoshinaga); Kōchi (III. Jan. 1. 1907. S. Kusano).

Kiushū.—Prov. Higo: Kamino-mura (II. June 6, 1906. H. Matsuo).—Prov. Chikuzen: Yanagawa (II. Sept. 17, 1906. K. Yoshino).

Formosa.—Daihoku (II. Dec. 5, 1905. T. Kawakami and R. Suzuki; II. T. Kawakami).

Distrib. Japan.

Remarks. Dietel (10) makes a remark that this fungus is closely related to *Uromyces ovalis* Diet. From my own observations, however, these two species evidently differ from each other in various points; that is, in color and shape of uredospores, in the dimension of teleutospores and pedicels and also in the shape of the sorus, as shown in the following table :—

	U. ovalis	*U. coronatus*
II. Color of spore	Light brown or brownish yellow.	Yellowish brown, apex darker.
Shape of spore	Globose, ellipsoidal or obovate.	Ellipsoidal, obovate or globose.
Germ-pores	5.	3—4.
III. Size of spore	$18-30 \times 13-19\,\mu$.	$20-40 \times 10-22\,\mu$.
Pedicel of spore	$30-40\,\mu$ in length.	$30-45\,\mu$ in length.
Shape of sorus	Oblong.	Linear or oblong.

B. Teleutospores not provided with coronate apex.

a. Teleutosori covered by epidermis.

3. **Uromyces Alopecuri** Seym. in Proc. Boston Soc. Nat. Hist., 24, 1889,

(186); Sacc., Syll., **9**, 1891, (295); Dietel, in Engl., Bot., Jahrb., **32**, 1903, (47).

var. **japonica** S. Ito. n. var.—(Pl. X. Fig. 3.)

Uredosori, amphigenous, mostly hypophyllous, or on the sheath, small, round or oblong, scattered or gregarious, often confluent, naked, with the torn epidermis, powdery, or sometimes loosely covered by the epidermis, especially on the sheath, orange-colored. Uredospores, subglobose or broadly ellipsoidal, minutely or prominently verrucose, 16—28 × 14—27 μ; epispore thick; paraphyses absent.

Teleutosori, amphigenous, mostly hypophyllous, or on the sheath and culm, those on the blade small, round or oblong, scattered, rarely confluent; those on the sheath and culm, small, round, oblong or linear, scattered or gregarious, often confluent; long covered by epidermis, somewhat pulvinate, not prominent, greyish black. Teleutospores, globose, obovate or polygonal, apex more or less thickened (3—4 μ) and rounded, truncate or obliquely pointed, base rounded or slightly attenuated, brownish yellow, darker at apex, 18—29 × 15—21 μ; epispore 1—1.5 μ thick; pedicels brown, persistent, as long as the spore or sometimes little longer.

Hab. On *Alopecurus fulvus* L.

Hokkaidō.—Prov. Ishikari: Sapporo (II. June 20, 1891. K. MIYABE); Nopporo (II. & III. July 27, 1905. J. HANZAWA); Garugawa (II. Sept. 22, 1907. S. ITŌ); Iwamizawa (II. July 10, 1908. S. ITŌ). —Prov. Iburi: Mororan (II. & III. June 10, 1900. K. MIYABE).

Honshū.—Prov. Rikuchū: Morioka (II. & III. May 30, 1903. G. YAMADA; II. July 3, 1907. M. MIURA).—Prov. Musashi: Tokyo (II. & III. July 1899; II. May 2, 1899. S. KUSANO); Nishigahara (II. & III. June 22, 1896. S. HORI; II. Nov. 29, 1899. T. NISHIDA); Kawaguchi (II. & III. May 31, 1906. N. NAMBU); Aoyama (II. & III. June 1902. K. YOSHINO).—Prov. Yamashiro: Kyoto (III. July 14, 1895 Y. TAKAHASHI); Kujō-mura, Kyoto (II. & III. June 8, 1895. N. HIRATSUKA).

Shikoku.—Prov. Iyo: Sugō-mura (II. May 22, 1899. K. OKUDAIRA).

Kiushū.—Prov. Chikuzen: Ōmuda (II. April 23, 1905. K. YOSHINO).—Prov. Higo: Imizumura (II. & III. May 26, 1904. K. YOSHINO); Mt. Aso (II. & III. July 13, 1906. J. HANZAWA & K. YOSHINO); Kumamoto (II. & III. June 2, 1907. T. NISHIDA).

Formosa.—Daihoku (II. & III. April 5, 1907. T. KAWAKAMI & R. SUZUKI).

On *Alopecurus japonicus* Steud.

Kiushū.—Prov. Higo: Imizu-mura (III. May 25, 1905. S. MAIHARA).

Distrib. Japan.

REMARKS. Comparing our specimens with the description of the American

Uromyces Alopecuri Seym. (1), I find the following points of difference :—

1. The uredosori are amphigenous or hypophyllous in our species and not epiphyllous as in the American species.

2. The measurement of our uredospores is a little larger (27 or 28 μ against 24 μ).

3. Though the teleutosori are written as epiphyllous, they are mostly hypophyllous in our species and also most commonly formed at the basal part of the sheath.

Although the essential characters of the uredospores and teleutospores are practically the same, the above mentioned differences in character being constant, I think it better to treat our plant as a variety of the American *Uromyces Alopecuri.*

4. Uromyces Setariae italicae (Diet.) Yoshino., in Bot. Mag. Tokyo, **20,** 1906, (247).—(Pl. X. Fig. 4.)

Syn.: *Uredo Setariae italicae* Diet., in Engl., Bot. Jahrb., **32,** 1903, (632); Sacc., Syll., **17,** 1905, (457); Sydow & Butler, in Ann. Mycol., **4,** 1906, (444).

Uredosori = *Uredo Setariae italicae* Diet.

Teleutosori, mostly hypophyllous or on the sheath; minute, oblong or roundish, scattered or gregarious, commonly not confluent, long covered by epidermis, somewhat pulvinate, inconspicuous, greyish-black. Teleutospores, spherical, obovate or oblong, mostly angular, apex not or slightly thickened, and rounded or truncate, base rounded or attenuated, brownish yellow or yellowish, 20—30 × 16—24 μ; epispore thick (2—3 μ); pedicels persistent, hyaline or subhyaline, as long as the spores.

Hab. On *Setaria italica* Beauv. var. *germanica* Trin.

Honshū.—Prov. Musashi: Tokyo (II. Oct. 3, 1901. S. Kusano; II. Sept. 26, 1896. S. Hori). —Prov. Rikuchū: Shinjō (II. & III. Sept. 26, 1897. Y. Takahashi).

Kiushū.—Prov. Higo: Kumamoto (II. May 1902. T. Kawakami; II. & III. Oct. 19, 1906. K. Yoshino).

On *Setaria viridis* Beauv.

Honshū.—Prov. Musashi: Tokyo (II. Sept. 29, 1896. S. Hori; II. Oct. 3, 1901. S. Kusano). —Prov. Izu: Shūzenji (II. Nov. 1, 1900. N. Nambu).

Distrib. Japan and India.

REMARKS. In 1903, DIETEL (7) for the first time described this species under the name of *Uredo Setariae italicae* from the specimens on *Setaria viridis* as well as on *Setaria italica* var. *germanica* sent to him from Prof. S. KUSANO, who had collected them in October 1901 in Tokyo.

In 1906, SYDOW and BUTLER (1) reported the same fungus from India as infecting *Setaria intermedia*, *S. italica*, *S. glauca* and *S. verticillata*.

Mr. K. YOSHINO (1) having found the teleutospores of the present species on *Setaria italica* var. *germanica* in 1906 at Kumamoto, described it and proposed to change the name of this species to *Uromyces Setariae italicae* (Diet.). He made the following remarks: "It seems to me, although it sometimes occurs abundantly in Kiushū, that damages caused by this fungus are not so severe, because its appearance is always late in season in the ripening period of the host-plant."

The reasons why we have difficulty in finding the teleutostage specimens of the present species may probably be due to the rarity of the teleutostage or to the inconspicuousness of its sori.

b. Teleutosori naked.

5. Uromyces Muehlenbergiae S. Ito n. sp.—(Pl. X. Fig. 5.)

Teleutosori, hypophyllous, very rarely epiphyllous; small, oblong or linear, scattered or gregarious, often confluent, naked, pulvinate, compact, prominent, blackish-brown. Uredospores frequently mixed in the sori.

Uredospores, globose, subglobose or ellipsoidal, minutely echinulate, 17—24 × 16—24 μ; epispore brownish yellow, 2—3 or 4 μ thick; germ-pores 3 or 4.

Teleutospores, subglobose, oval or oblong, apex rounded, angular or apiculate, thickened (6—13 μ), base rounded, smooth, chestnut-brown, darker colored at apex, 18—28 × 12—21 μ, rarely 32 μ in length; epispore rather thick; pedicels brownish colored, persistent, 10—42 μ, sometimes 60 μ; paraphyses absent.

Hab. On *Muehlenbergia japonica* Steud.

Hokkaidō.—Prov. Ishikari: Sapporo (III. Oct. 1890. K. MIYABE).—Prov. Shiribeshi: Zenibako (III. Oct. 9, 1895. K. MIYABE).

Distrib. Japan.

REMARKS. The only species of Uromyces known to grow on *Muehlenbergia* is *U. minimus* Davis in North America. To that species, our plant is closely related, but there are some points of difference between them, that would warrant us to consider them as distinct species. The characteristic by which our species can easily be recognized from the American, is the entire absence of paraphyses in the teleutosorus of our plant.

PUCCINIA Pers.

A. Teleutospores provided with coronate apex.

1. Puccinia coronata Cda., Icon. Fung., **1**, 1837, (6); Winter, Pilze, **1**, 1884, (218); Sacc., Syll., **7**, 1888, (623); Schroeter, Pilz Schles., 1889, (323); Plowr., Brit. Ured. and Ustil., 1889, (163); Kleb., Zeits. f. Pflanzenk., **2**, 1892, (337); **4**, 1894, (131); 5, 1895, (151), (327); **6**, 1896, (331); **8**, 1898, (26); Eriks. et Henn., Die Getreideroste, 1896, (240); P. Henn., in Engl., Bot. Jahrb., **31**, 1902, (732); Sydow, Monogr. Ured., **1**, 1904, (699); Fischer, Ured. Schw., 1904, (373); Dietel, in Engl., Bot. Jahrb., **37**, 1905, (100); in Ann. Mycol., **5**, 1907, (73).—(Pl. X. Fig. 13.)

Hab. On *Calamagrostis arundinacea* Roth. var. *sciuroides* Hack.

Honshū.—Prov. Musashi: Ōmiya (III. Nov. 20, 1899. T. NISHIDA); Kobotoke (II. & III. Oct 16, 1906. N. NAMBU).

Kiushū.—Prov. Higo: Sannō-dake (III. Oct. 8, 1905. K. YOSHINO).

On *Calamagrostis robusta* Fr. et Sav.

Honshū.—Prov. Musashi: Tokyo (III. Nov. 1, 1904. M. SHIRAI; III. Oct. 25, 1904. S. KUSANO).

Distrib. Europe, North America, Asia and Australia.

REMARKS. In 1892, KLEBAHN (1) remarked on the presence of two kinds of coronate Puccinia; which had generally been regarded as a single species under the name of *Puccinia coronata*. They are *Puccinia coronata* and *P. coronifera* (2) (=*P. Lolii* Niels.). The former species is related to the Æcidium on *Rhamnus Frangula* and the latter to the Æcidium on *R. cathartica*. ERIKSSON and KLEBAHN by a long series of careful experiments proved the presence of many specialized forms in both of these species.

In our country, there are many species of coronate Puccinia; but only those of *Calamagrostis arundinacea* var. *sciuroides* and *C. robusta*, although

little longer spores are sometimes found intermixed, coincide with the descriptions and European specimens of *P. coronata*.

2. **Puccinia Lolii** Niels., Ugeskrift for Landwaend., **9**, 1875, (549); Magnus, Oesterr. Bot. Zeitschr., **51**, 1901, (89); Sydow, Monogr. Ured., **1**, 1904, (704); McAlpine, The Rusts of Australia, 1906, (123).

Syn.: *Puccinia coronifera* Kleb., in Zeitschr. f. Pflanzenk., **3**, 1893, (199); **4**, 1894, (132); **5**, 1895, (151, 327); **6**, 1896, (331); Sacc., syll., **11**, 1895, (203); Eriksson, in Centralbl. f. Bact. &c. II., **3**, 1897, (302); Fischer, Ured. Schw., 1904, (375); Takahashi, in Trans. Sap. Nat. Hist. Soc., **1**, 1906, (46).

Hab. On *Avena sativa* L.

Hokkaidō.—Prov. Ishikari: Sapporo (II. Oct. 4, 1892. K. Miyabe; II. Sept. 12, 1903; II. June 17, 1903. T. Miyake); Tsuishikari (II. Sept. 29, 1907; II. Sept. 27, 1908. S. Itō); Ebetsu (II. Sept. 29, 1907. S. Itō); Shiroishi (II. & III. Oct. 6, 1908. S. Itō).

Honshū.—Prov. Rikuchū: Morioka (II. Sept. 1906. B. Fukuta).—Prov. Echizen: Fukui (II. Aug. 1907. A. Ideta).

Kiushū.—Prov. Higo: Kumamoto (III. July 13, 1904. K. Yoshino); Aso (II. & III. Aug. 1901. T. Kawakami).

On *Avena fatua* L.

Honshū.—Prov. Musashi: Shinagawa (II. May 27, 1903. K. Miyabe).

On *Avena sterilis* L.

Hokkaidō.—Prov. Ishikari: Sapporo (II. Oct. 1907. S. Itō).

Distrib. Europe, North America, Asia and Australia.

Remarks. In 1892, Klebahn (1) proving its relation to the Æcidium on *Rhamnus cathartica* L. separated the present species from the old *Puccinia coronata* Cda., under the name of *Puccinia coronifera* (2). But Nielsen (1) in 1875 had already found a similar relation existing between the Æcidium on *Rhamnus cathartica* and the coronate Puccinia on *Lolium perenne* and he gave it the name of *Puccinia Lolii*, which should be adopted on account of its priority.

Eriksson and Klebahn recorded six specialized forms to this species, and among them *f. sp. Avenæ* only has been found in our country. The uredospore-stage is common in our country, but the teleutospore-stage seldom occurs. Last fall I found the teleutostage on oats in the vicinity of Sapporo,

which I think is the first collection made in Hokkaidō. McALPINE (1) remarked, that the teleutospores of this species on *Avena fatua* in Australia are longer than those on *Avena sativa*, reaching 86μ in length. In our country, I have not been able to find any teleutospore on the former host-plant, although the uredospore-stage is found. On examining our specimens on *Avena sativa*, however, I noticed the dimension of the teleutospore is slightly longer than that of Europe, the maximum length reaching 72μ in ours, while in European forms only 60μ. In other respects, they thoroughly coincide with each other.

The æcidial stage of this species as well as of *Puccinia coronata* is not yet found in Japan.

3. Puccinia himalensis (Barcl.) Diet., in Engl. u. Plantl, Naturl. Pflanzenfam., **1**, Th.** 1900, (63); Sydow, Monogr. Ured., **1**, 1904, (738); Sacc., Syll., **17**, 1905, (386); Dietel, in Engl., Bot. Jahrb., **37**, 1905, (100); in Ann. Mycol., **6**, 1908, (223).

Syn.: *Puccinia coronata* Cda. var. *himalensis* Barcl., in Trans. Lin. Soc., **3**, 1891, (229).

Hab. On *Brachypodium silvaticum* Beauv.

Honshū.—Prov. Izu: Irōzaki (III. June 2, 1904. S. KUSANO).

On *Brachypodium japonicum* Miq.

Honshū.—Prov. Mutsu: Hirosaki (III. Nov. 1896. N. HIRATSUKA).—Prov. Rikuchū: Morioka (III. Nov. 3, 1905. G. YAMADA).

Distrib. Japan and India.

REMARKS. DIETEL (2) elevated the BARCLEY'S var. *himalensis* of *Puccinia coronata* to a distinct specific rank on account of the smaller size of æcidiospores (13–16 × 10–15μ) and of naked teleutosori.

In Japan, Prof. S. KUSANO collected this species for the first time on *Brachypodium silvaticum* in Prov. Izu, and DIETEL identified it with the Himalayan species. In the present paper a new host-plant, *Brachypodium japonicum*, is added to the fungus.

An Æcidium on *Rhamnus japonicus*, sent to DIETEL from our country was considered by him as a stage of *Puccinia himalensis* (7). But afterwards another Æcidium on *Rhamnus japonicus* was reported by the same

author (8) as a distinct species on account of the dense aggregation of Æcidia in a larger group, and of the larger size of æcidiospores. He named it *Æcidium Rhamni japonici*. Infection experiment ought to be performed in order to settle the question, whether the Æcidium on *Rhamnus japonicus* has a genetic relation to *Puccinia himalensis* or not.

At Jōzankei, near Sapporo, Mr. KASAI collected a coronate Puccinia on the leaves of certain grass which does not belong to *Brachypodium*. The general character of its teleutospore coincides morphologically to those of the present species.

4. Puccinia Diarrhenæ Miyabe et Itō. n. sp.—(Pl. X. Fig. 6.)

Teleutosori, epiphyllous; minute or medium sized, oblong or round, scattered or gregarious, sometimes confluent, loosely covered by epidermis, soon after naked with the torn remains, somewhat pulvinate, compact, sooty black. Uredospores are sometimes found intermixed in the sori.

Uredospores, obovate, subglobose or globose, verrucoso-echinulate, light brownish yellow or hyaline, 20–26.5 × 16–23.5μ; epispore thin (1–2μ).

Teleutospores, oblong-clavate, ellipsoidal or fusiform, apex slightly thickened, with numerous blunt, rather short horn-like (6–17μ in length) or wart-like processes, base mostly attenuated, not or slightly constricted at the septum, smooth, ferruginous at the apex, lighter colored toward the base, 25–52 × 10–21.5μ; epispore rather thin; pedicels hyaline or light yellowish at the upper portion, as long as the spore in length, persistent.

Hab. On *Diarrhena japonica* Fr. et Sav.

Honshū.—Prov. Rikuchū: Morioka (III. Oct. 21, 1906. G. YAMADA).—Prov. Uzen: Minamura (III. Aug. 25, 1903. Y. TAKAHASHI).

Distrib. Japan.

REMARKS. The occurrence of Puccinia on *Diarrhena* seems never to have been recorded so far. In our country, the present host-plant, *Diarrhena japonica* Fr. et Sav. is widely distributed though not common. The specimens of the fungus we have examined are only two in number, and in both of them the uredosori could not be found. Only a few of the uredospores we have observed were intermixed with the teleutospores. Among many coronate species of Puccinia on Gramineæ there are none provided with

such a long pedicel as in this species. *Puccinia Festucæ* Plowr., it is true, has a long pedicel (15–25μ in length), but it is just about half the length of the pedicel of the species under consideration. Moreover, these two species differ from each other in so many points, that there is no need of questioning their identity.

5. Puccinia brevicornis S. Itō. n. sp.—(Pl. X. Fig. 7.)

Uredosori, amphigenous, mostly hypophyllous; small, oblong, or sublinear, on the yellowish discolored spots, gregarious, scattered or somewhat arranged in lines, rarely confluent, naked, with the ruptured epidermis, pulverulent, orange-colored. Uredospores ellipsoidal, globose or obovate, echinulate, 14–21 × 12–16μ; epispore comparatively thick; hyaline or somewhat yellowish; paraphyses sometimes present, few in number, hyaline, clavate or capitate, apex not thickened.

Teleutosori, hypophyllous, rarely epiphyllous; small, oblong or sublinear, densely scattered, often confluent, loosely covered by epidermis or naked with the ruptured remains, pulvinate, compact, conspicuous, black. Teleutospores cylindrical, oblong-clavate, thickened (6–8μ) at apex, truncate, with the tubercular, short blunt horn-like processes or slightly undulate, base attenuated, not or slightly constricted at the septum, smooth, chestnut-brown, darker at apex, 40–74 × 12–24μ; epispore rather thin; pedicels very short, brown, persistent.

Hab. On *Calamagrostis villosa* Mut.

Hokkaidō.—Prov. Ishikari: Sapporo (III. Oct. 1894.; III. Oct. 18, 1897. K. Miyabe; III. Oct. 28, 1895. Y. Tokubuchi; II. & III. March 2, 1896. J. Tochinai; II. July 20, 1907; III. Oct. 4, 1907. S. Itō); Tsuishikari (II. & III. Sept. 21, 1902. G. Yamada; II. & III. Oct. 1, 1905; III. Sept. 29, 1907. S. Itō; III. Oct. 6, 1907. M. Kasai); Okatama (III. Oct. 17, 1903. T. Miyake); Kamuikotan (II. & III. Oct. 9, 1907. S. Itō); Chikabumi (II. July 10, 1905. T. Miyake).

On *Calamagrostis canadensis* Beauv.

Hokkaidō.—Prov. Ishikari: Sapporo (III. Nov. 5, 1897. K. Miyabe).

Distrib. Japan.

Remarks. The present fungus seems to be restricted to *Calamagrostis villosa* Mut., which is quite common in Hokkaidō. It is also found on *Calamagrostis canadensis* cultivated in the College Botanical Garden, but not on other species of the genus. Very short processes at the tip of the teleuto-

spores are the characteristic by which this species can easily be distinguished from other coronate species of Puccinia.

6. Puccinia Epigejos S. Itō n. sp.—(Pl. X. Fig. 8.)

Uredosori, epiphyllous, sometimes hypophyllous; minute, oblong or linear, scattered or gregarious, on discolored spots, sometimes confluent, loosely covered by the epidermis, or naked, with ruptured remains, pulverulent, orange-colored. Uredospores ellipsoidal, oval or globose, echinulate, 24–36 × 20–26μ; epispore thin, yellowish brown or hyaline; paraphyses numerous, capitate or clavate, hyaline or subhyaline, apex not thickened.

Teleutosori, epiphyllous, rarely hypophyllous in severe cases, or on the sheath; small, oblong or linear, scattered or gregarious, often confluent, reaching on the leaves 4 mm. in length, on the sheath 1.5 cm. long, naked, with ruptured epidermis, pulvinate, compact, conspicuous, black. Teleutospores cylindrical, long-clavate, apex thickened (4–6μ), with the blunt, horn-like processes, base attenuated, not or slightly constricted at the septum, smooth, ferruginous or chestnut-brown, darker at apex, 36–92 × 14–20μ; epispore thin; pedicels very short, brown, persistent.

Hab. On *Calamagrostis Epigejos* Roth. var. *densiflora* Led.

Hokkaidō.—Prov. Ishikari: Sapporo (II. & III. Oct. 19, 1894; II. & III. Oct. 10, 1895. N. HIRATSUKA; II. & III. Oct. 16, 1907. S. ITŌ); Shiroishi (II. Aug. 8, 1895. N. HIRATSUKA); Asahigawa (III. Oct. 8, 1907. S. ITŌ); Nagayama (III. Oct. 7, 1907. S. ITŌ); Garugawa (II. & III. Sept. 22, 1907. S. ITŌ).—Prov. Shiribeshi: Zenibako (II. Aug. 6, 1895; II. Aug. 2, 1899. K. MIYABE).

Distrib. Japan.

REMARKS. This fungus is found everywhere in Hokkaidō, where *Calamagrostis Epigejos* Roth. var. *densiflora* Led. grows abundantly.

Naked teleutosori are commonly epiphyllous. The teleutospores are longer and larger compared with those of *Puccinia coronata*. Especially the uredospores are the largest among the coronate species of Puccinia. ERIKSSON recorded *Puccinia coronata* as occuring on the present host-plant. His descriptions in regard to the measurement of the uredospore and the teleutospore do not coincide with those of our present species, which I have consequently treated here as a new species.

7. Puccinia pertenuis S. Itō n. sp.—(Pl. X. Fig. 9.)

Teleutosori, hypophyllous, rarely epiphyllous; minute, oblong or linear, densely scattered over the discolored portion, sometimes confluent, naked or loosely covered by the epidermis, pulvinate, compact, conspicuous, black. Uredospores mixed in the sori.

Uredospores ellipsoidal to globose, echinulate, 16–24 × 16–18μ; epispore thin, light yellowish; paraphyses short, obovate-clavate, light brownish-colored, apex not thickened, 30–55 × 20–26μ.

Teleutospores cylindrical, linear or oblong clavate, apex thickened, coronate with numerous blunt somewhat long processes, base attenuated, scarcely constricted at the septum, ferruginous, darker at apex, 40–72 × 10–16μ; epispore very thin; pedicels brown, short, subdeciduous.

Hab. On *Calamagrostis arundinacea* Roth. var. *nipponica* Hack.

Honshū.—Prov. Sagami: Hakone (H. J. MATSUMURA).

Distrib. Japan.

REMARKS. This species resembles *Puccinia coronata* in the position and macroscopical appearance of their teleutosori, but they can easily be distinguished from each other microscopically.

In the general form of the teleutospores, our plant resembles *Puccinia Epigeios*, from which it differs, however, in the position of its teleutosori and in the smaller size of its uredospores.

8. Puccinia Hierochloæ S. Itō n. sp.—(Pl. X. Figs. 10, 11.)

Uredosori, amphigenous, mostly epiphyllous, or on the sheath; small oblong or linear, densely or loosely scattered over the surface, often confluent, naked or loosely covered by the epidermis, pulverulent, orange-colored. Uredospores ellipsoidal to globose, echinulate, 16–26.5 × 12–18μ; epispore comparatively thick, hyaline or yellowish; paraphyses sometimes present, clavate or capitate, hyaline, apex not thickened, 50–72 × 10–15μ.

Teleutosori, amphigenous, mostly epiphyllous or on the sheath; small or medium in size, oblong or linear, scattered or gregarious, often confluent (2–4 mm.), loosely covered by the epidermis, becoming soon naked with ruptured remains, pulvinate, compact, conspicuous, black. Teleutospores cylindrical, oblong-clavate or linear-clavate, apex thickened, with the nu-

merous blunt, rather long processes, generally more or less divergent, base attenuated, not or slightly constricted at the septum, smooth, ferruginous or light chestnut-brown, 30–80 × 14–22μ, rarely 104μ in length; epispore thin; pedicels very short, brown, subdeciduous.

Hab. On *Hierochloë borealis* Roem.

Hokkaidō.—Prov. Ishikari: Sapporo (III. Oct. 1894; III. Oct. 23, 1896; III. Oct. 10, 1899. K. MIYABE; III. Sept. 15, 1899. G. YAMADA); Tsukisappu (III. June 1896. K. MIYABE; III. May 15, 1903. S. ITŌ); Ishikari (II. & III. Sept. 24, 1899. G. YAMADA); Kamikawa (III. Oct. 1, 1899. T. KAWAKAMI); Kamuikotan (III. Oct. 8, 1906. K. MIURA); Tsuishikari (II. & III. Sept. 29, 1907. S. ITŌ).—Prov. Shiribeshi: Esashi-Gorinzawa (II. Aug. 10, 1902. G. YAMADA).—Prov. Iburi: Numanohata (III. Nov. 1, 1900. K. MIYABE & G. YAMADA).

Honshū.—Prov. Mutsu: Goshogawara (III. Oct. 1904. T. KASHIWAI).

On *Stipa sibirica* Lam.?

Honshū.—Prov. Rikuchū: Morioka (III. Oct. 29, 1905. G. YAMADA).

Distrib. Japan.

REMARKS. SYDOW (1) notices the presence of a species of coronate Puccinia on *Hierochloë sp.* in Europe without giving any description. Our fungus may be identical with the European species. The present species can easily be distinguished from common *Puccinia coronata* by the epiphyllous position and larger size of its teleutosori. The general appearance of the teleutospore resembles that of *Puccinia Epigejos*, but it differs in its longer and more or less divergent processes at the apex. Moreover, the uredospore of the present species is in general smaller in size than that of the species just referred to.

The length of the lower cell of its teleutospore is very variable, some reaching even 70μ, which is in fact longer than the largest teleutospores in *Puccinia coronata*. A similar fungus is found on *Stipa sibirica?* collected at Morioka by Prof. G. YAMADA, and I have placed it in the present species.

9. Puccinia rangiferina S. Itō n. sp.—(Pl. X. Fig. 12.)

Teleutosori, hypophyllous or on the sheath; small or medium in size, oblong or linear, scattered or gregarious, often confluent, naked, with the ruptured epidermis, pulvinate, compact, conspicuous, black. Teleutospores cylindrical or oblong-clavate, apex thickened, with 2–9 long, sometimes branching, divergent processes (maxim. about 31μ), base attenuated, not or

slightly constricted at the septum, smooth, ferruginous, darker at apex, 24–102 × 11–21 μ; epispore thin; pedicels very short, subdeciduous.

Hab. On *Calamagrostis arundinacea* Roth. var. *sciuroides* Hack.

Honshū.—Prov. Rikuchū: Morioka (III. Oct. 29, 1905. G. YAMADA).

Distrib. Japan.

REMARKS. The teleutospores of the present species are provided with remarkably long and elegant processes at the apex, and we can easily distinguish it from other related species.

B. Teleutospores not provided with coronate apex.

a. Teleutosori covered by the epidermis.

α. Paraphyses absent in uredosori.

10. Puccinia glumarum (Schmidt) Eriks. et Henn. in Zeits. f. Pflanzenk. **4,** 1894 (197); Die Getreideroste, 1896, (141); Henn., Engl., Bot. Jahrb., **31,** 1902, (731); Sydow, Monogr. Ured., **1,** 1904, (706); Fischer, Ured. Schw., 1904, (366); Sacc., Syll., **17,** 1905, (380); Takahashi, in Trans. Sap. Nat. Hist. Soc., **1,** 1906, (39); Butler and Hayman, in Mem. of the Depart. of Agric. in India, **1,** 1906, (28).

Hab. On *Hordeum sativum* Jess.

Hokkaidō.—Prov. Ishikari: Sapporo (II. June 20, 1900. S. YŪKI; II. July 24, 1900. G. YAMADA; II. July 1, 1904. T. MIYAKE; II. & III. Sept. 14, 1905. K. MIYABE & J. HANZAWA); Tsuishikari (II. July 1895. K. MIYABE); Bebetsu (III. July 22, 1905. T. MIYAKE).—Prov. Oshima: Higashi-ozaki-mura (III. July 13, 1902. T. MIYABE).

Honshū.—Prov. Musashi: Mejiro (II. & III. July 14, 1907. N. NAMBU).

Kiushū.—Prov. Higo: Kumamoto (III. July 1903. K. YOSHINO); Imizu-mura (II. Jan. 23, 1906. K. YOSHINO).

On *Hordeum sativum* Jess. (*Hadaka-mugi*).

Hokkaidō.—Prov. Ishikari: Sapporo (III. July 31, 1903. Y. TAKAHASHI).—Prov. Teshio: Utatoshibetsu (III. July 22, 1903. Y. TAKAHASHI); Mashike (II. July 20, 1903. Y. TAKAHASHI).

Kiushū.—Prov. Higo: Imizu-mura (II. Nov. 9, 1906. K. YOSHINO).

On *Triticum vulgare* Vill.

Hokkaidō.—Prov. Ishikari: Sapporo (II. & III. Aug. 12, 1895. N. HIRATSUKA; II. & III. July 24, 1900. G. YAMADA; II. July 6, 1901. T. MIYAKE; II. July 6, 1904; III. July 30, 1903. Y. TAKAHASHI; III. July 20, 1904. T. MIYAKE; II. July 12, 1907; III. Oct. 12, 1907. S. ITŌ); Asahigawa (II. Oct. 8, 1907. S. ITŌ); Bebetsu (III. July 22, 1905. T. MIYAKE).

Honshū.—Prov. Musashi: Tokyo (II. & III. June 4, 1899. S. KUSANO); Meguro (II. May 18,

1902. N. NAMBU).—Prov. Rikuchū: Morioka (II. July 21, 1907. G. YAMADA); Kuzumaki (II. & III. July 6, 1907. M. MIURA).—Prov. Kōzuke: Ōda (II. June 5, 1906. G. MATSUMURA).—Prov. Echigo: Fukuto-mura (II. June 1903. K. YOSHINO).—Prov. Echizen: Fukui (II. 1907. A. IDETA).—Prov. Settsu: Ōsaka (III. 1906. A. IDETA).

Kiushū.—Prov. Higo: Kumamoto (III. June 1907. T. TADA); Jinnai-mura (III. May 20, 1905. K. YOSHINO); Kuhonji-mura (II. May 1, 1905. K. YOSHINO).

Shikoku.—Prov. Iyo: Kuwahara (II. June 1900. K. OKUDAIRA); Sugō-mura (II. June 10, 1899. K. OKUDAIRA).

On *Triticum monococcum* L. (cult.)

Hokkaidō.—Prov. Ishikari: Sapporo Bot. Gard. (III. Sept. 1902. T. MIYAKE).

Distrib. Europe, North America, Asia and Africa.

REMARKS. The yellow rust, as this fungus is now generally known, occurs more frequently on wheat than on barley in several parts of Japan. This species can easily be distinguished macroscopically from other rust fungi on cereals by the yellowish discolored streaks of the uredosori on the leaves and also by the streak-dotted arrangement of the teleutosori on the sheath.

This species was at first included with other species in *Puccinia rubigo-vera* DC. (*P. striæformis* West., *P. straminis* Fuck.). In 1894, ERIKSSON and HENNING (1) divided *Puccinia rubigo-vera* into two species, viz., *P. glumarum* (Schmidt.) and *P. dispersa* by their morphological characters. In 1899, ERIKSSON (4) divided old *P. rubigo-vera* still further into the following eight species:—

1. *Puccinia glumarum* (Schmidt.) Eriks. et Henn.
   The yellow rust (Æcidium unkown).
2. *P. dispersa* Eriks. (not Eriks. et Henn.)
   The brown rust of rye (Æcidium on *Anchusa*).
3. *P. triticina* Eriks.
   The brown rust of wheat (Æcidium unknown).
4. *P. Symphyti-Bromorum* Müll. (=P. bromina Eriks.)
   The brown rust of bromes (Æcidium on *Symphytum*).
5. *P. agropyrina* Eriks.
   On *Triticum repens* (Æcidium unknown).
6. *P. holcina* Eriks.
   On *Holcus lanatus*, *H. mollis* (Æcidium unknown).

7. *P. Triseti* Eriks.

On *Trisetum flavescens* (Æcidium unknown).

8. *P. simplex* (Kcke) Eriks. et Henn.

The dwarf rust of barley (Æcidium unknown).

No. 1, 2, 3, 4 and 8 are found in our country.

Further, ERIKSSON subdivided *Puccinia glumarum* into the five following specialized forms :—

1. *f. sp. Tritici.*
2. *f. sp. Hordei.*
3. *f. sp. Secalis.*
4. *f. sp. Elymi.*
5. *f. sp. Agropyri.*

In Japan, the first two forms only have been found so far.

11. Puccinia dispersa Eriks. in Ann. d. Sc. nat. 8 s, **9,** 1899, (241); Fischer, Ured, Schw., 1904, (357); Takahashi, in Trans. Sap. Nat. Hist. Soc., **1,** 1906, (44).

Hab. On *Secale cereale* L.

Hokkaidō.—Prov. Ishikari: Sapporo (II. June 28, 1895. Y. TOKUBUCHI; II. Aug. 1, 1895. K. MIYABE; II. Sept. 16, 1897. T. NISHIDA; II. July 24, 1900. G. YAMADA; II. & III. Aug. 24, 1904. Y. TAKAHASHI; II. July 12, 1907. S. ITŌ).

Honshū.—Prov. Rikuchū: Morioka (II. May 1906. B. FUKUTA); Osawa (II. July 12, 1907. G. YAMADA.)

Distrib. Europe, Asia minor, Siberia, Japan and North America.

REMARKS. As was remarked in the case of *Puccinia glumarum*, this species was formerly included in *Puccinia rubigo-vera*, from which ERIKSSON (1) had separated it as a distinct species. By infection experiments, he has divided it into the four following specialized forms :—

1. *f. sp. Secalis.*
2. *f. sp. Tritici.*
3. *f. sp. Bromi.*
4. *f. sp. Agropyri.*

Five years later, ERIKSSON (4) elevated the *f. sp. Secalis* into a specific rank and gave to it the name *Puccinia dispersa* Eriks. (not Eriks. et

Henn.). Three other specialized forms also have been given independent specific positions to which I shall refer later on.

The aecidial stage of the species under consideration is known to occur on *Anchusa arvensis* and *A. officinalis* in Europe. As there are no species of *Anchusa* in our flora, the aecidial stage may have been altogether abbreviated in our country. *Anchusa officinalis* is cultivated on our College farm, but we have not yet found any Æcidium growing upon it.

The specimens of *Puccinia dispersa* which I have examined are rather scanty in number, as rye is not yet widely cultivated in our country. I have specimens only from Sapporo and Morioka. In the vicinity of Sapporo, rye is annually attacked rather severely by the uredospores of this fungus. Its teleutospores, however, are seldom found.

12. Puccinia triticina Eriks. in Ann. d. Sc. nat., 8 s, **9**, 1899, (270); Sydow, Monogr. Ured., **1**, 1904, (716); Fischer, Ured. Schw., 1904, (366); Sacc., Syll., **17**, 1905, (376); Butler and Hayman, Mem. Depart. Agric. India, **1**, 1906, (30); Takahashi, Trans. Sap. Nat. Hist. Soc. **1**, 1906, (42).

Hab. On *Triticum vulgare* Vill.

Hokkaidō.—Prov. Ishikari: Sapporo (III. July 21, 1892. T. NAKANO; II. June 28, 1895, Y. TOKUBUCHI; III. Aug. 1, 1895. K. MIYABE; II. & III. July 20, 1900. S. YŪKI; II. & III. July 24, 1900. G. YAMADA; III. July 27, 1901; III. Aug. 1904; II. & III. Aug. 25, 1904. Y. TAKAHASHI; II. July 12, 1907; II. Aug. 25, 1907. S. ITŌ); Kamikawa (II. Oct. 1, 1899. T. KAWAKAMI); Yamahana (II. July 31, 1900. K. MIYABE); Nagayama (II. Aug. 25, 1903. K. MIYABE); Tsuishikari (II. Sept. 29, 1907. S. ITŌ).—Prov. Shiribeshi: Hassoku-mura (III. July 28, 1897. G. YAMADA).

Honshū.—Prov. Rikuchū: Morioka (II. & III. July 14, 1907. G. YAMADA).—Prov. Musashi: Tokyo (II. & III. June 4, 1899. KUSANO); Hachiōji (II. June 11, 1898. S. KUSANO); Nishigahara (III. June 7, 1902. K. YOSHINO).—Prov. Echigo: Teradomari (II. April 13, 1903, K. YOSHINO); Nagaoka (II. May 8, 1903. K. YOSHINO); Tsubame (II. & III. July 29, 1908. S. ITŌ).—Prov. Echizen: Fukui (II. & III. June 1907. A. IDETA).—Prov. Mino: Tomokata-mura (II. & III. May 28, 1899. YAMAGUCHI); Kamiida-mura (II. May 22, 1899. YAMAGUCHI).—Prov. Settsu: Ōsaka (III. 1906. A. IDETA).

Kiushū.—Prov. Higo: Kumamoto (III. March 2, 1905; III. May 25, 1906. K. YOSHINO); Imizu-mura (II. March 2, 1905; III. May 8, 1906. K. YOSHINO); Kurokami-mura (III. June 2, 1907. T. TADA).

Distrib. Europe, India, Japan and North America.

REMARKS. The *f. sp. Tritici* of *Puccinia dispersa* Eriks. et Henn. was elevated to a distinct species by ERIKSSON (4) after careful investigations. Its accidial stage is not yet found.

In Hokkaidō, this fungus occurs abundantly on wheat, causing great damage. It is often found mixed with *Puccinia glumarum*, from which it can easily be distinguished by the scattered brownish uredosori, and also by the light brownish membrane of the uredospore. Moreover, the teleutosori of *Puccinia glumarum* are arranged in serial dots on the sheath, while those of *Puccinia triticina* are irregularly scattered; and also the teleutospores of *Puccinia triticina* are generally not so long and unsymmetrical as those of *Puccinia glumarum*.

These distinguishing characters can readily be observed in fresh materials, but in dried specimens it is somewhat difficult to distinguish them from each other by the color of the uredosori, as the color is liable to fade when dried. Also the streaked nature of the teleutosori in *Puccinia glumarum* often becomes indistinguishable when severely attacked, and moreover, *Puccinia triticina* may rarely show the serial sori on the sheath. Consequently, when a dried specimen is to be examined, great care is needed to distinguish these two species.

13. Puccinia Symphyti-Bromorum Fr. Müll., in Beihefte Bot. Centralb., **10**, 1901, (201): Fischer, Ured. Schw., 1904, (359).

Syn.: *Puccinia bromina* Eriks. in Ann. d. Sc. nat., 8 s, **9**, 1899, (271); Sydow, Monogr. Ured., **1**, 1904, (712); Sacc., Syll., **17**, 1905, (382); McAlpine, Rusts of Australia, 1906, (116).

Hab. On *Bromus pauciflorus* Hack.

Honshū.—Prov. Rikuchū: Morioka (II. & III. Oct. 20, 1907. K. Okumura).

Distrib. Europe, Asia minor, Japan and Australia.

Remarks. At first Eriksson (1) considered this species as a specialized form of *Puccinia dispersa* Eriks. et Henn. Later he regarded it as a distinct species and named it *Puccinia bromina* Eriks. (4). In 1901, Fr. Müller (1) found the aecidial stage of the fungus by infection experiments and gave it the name which I have adopted in this paper. Its presence in Japan has not been known to us hitherto. A specimen, collected by Mr. Okumura, and sent to me through the kindness of Prof. G. Yamada, agrees in nearly all of its characteristics to the present species.

The aecidial stage of this fungus is not yet found in our country.

14. **Puccinia simplex** (Koern.) Eriks. et Henn. in Zeits. f. Pflanzenk., **4**, 1894, (259); Die Getreideroste, 1896, (238); Sydow, Monogr. Ured., **1**, 1904, (756); Fischer, Ured. Schw., 1904, (368); Sacc., Syll., **17**, 1905, (377);, McAlpine, Rusts of Australia, 1906, (130); Takahashi, Trans. Sap. Nat. Hist. Soc., 1, 1906, (43).

Hab. On *Hordeum sativum* Jess.

Hokkaidō.—Prov. Ishikari: Sapporo (II. Aug. 1895. K. MIYABE; II. July 28, 1901. J. HANZAWA; III. Aug. 1, 1904. Y. TAKAHASHI); Kotoni-mura (II. July 13, 1894. K. MIYABE); Osarappe (II. Oct. 6, 1905. T. MIYAKE).—Prov. Shiribeshi: Okushiri (II. July 27, 1890. K. MIYABE).

Honshū.—Prov. Rikuchū: Morioka (III. May 1906. B. FUKUTA; June 23, 1907; July 14, 1907. G. YAMADA); Kuzumaki (II. & III. July 6, 1907. M. MIURA).—Prov. Uzen: Yamagata (III. Nov. 10, 1907. S. MURAYAMA).—Prov. Musashi: Tokyo (II. May 14, 1902. K. YOSHINO).—Prov. Echizen: Fukui (III. June 1907. A. IDETA).

Shikoku.—Prov. Iyo: Sugō-mura (II. May 22, 1899; June 10, 1899. K. OKUDAIRA).

Kiushū.—Prov. Higo: Kumamoto (III. April 28, 1905. S. MAHIHARA; II. & III. May 28, 1906. K. YOSHINO); Imizu-mura (II. May 25, 1905; II. June 1905. K. YOSHINO); Sunatori-mura (II. May 26, 1906. K. YOSHINO).

On *Hordeum sativum* Jess. (*Hadaka-mugi*)

Hokkaidō.—Prov. Kushiro: Ririran (II. July 27, 1904. Y. TAKAHASHI).

Honshū.—Prov. Sagami: Nagai-mura (II. May 4, 1904. K. MIYABE).—Prov. Echizen: Fukui (II. June 3, 1907. A. IDETA).

Kiushū.—Prov. Higo: Kumamoto (II. April 23, 1907. T. TADA); Imizu-mura (II. Nov. 9, 1906. K. YOSHINO); Sunatori-mura (III. June 1905, K. YOSHINO).

Distrib. Europe, Asia minor, Japan and Australia.

REMARKS. The "brown or dwarf rust of barley" occurs more frequently and causes greater damage than *Puccinia glumarum*. This species, by the frequent occurrence of the single celled teleutospores and by the smaller uredosori, is easily distinguishable from other species parasitic on cereals.

This species was regarded as *Puccinia straminis* Fuck. var. *simplex* by KOERNICKE in 1865. In 1875, it was named as *Uromyces Hordei* Nielsen, and in 1876 as *Puccinia anomala* Rostrup. In 1894, ERIKSSON and HENNING (1) regarded it also as an independent species and gave it the present name.

15. **Puccinia Glyceriæ** S. Itō. n. sp.—(Pl. XI. Fig. 2.)

Syn.: *Puccinia Panicullariæ* Diet. in Ann. Mycol., **6**, 1908, (224).

Uredosori, amphigenous, mostly epiphyllous ; minute, oblong or roundish, on the yellowish discolored portions, gregarious or scattered, sometimes confluent, loosely covered by epidermis, soon after ruptured, pulverulent, orange-colored. Uredospores globose, subglobose or broadly ellipsoidal, echinulate, light yellowish colored or hyaline, $20-28 \times 18-24\,\mu$; paraphyses absent.

Teleutosori, hypophyllous ; minute or medium sized, oblong or linear, gregarious, somewhat arranged in lines, sometimes confluent (rarely 1 cm. in length), almost always covered by the epidermis, pulvinate, compact, black- or grey-colored. Teleutospores subcylindrical or cylindrical, apex truncate or wavy, thickened ($5-6\,\mu$, rarely $8\,\mu$), base tapering toward the pedicel, or angular, not or slightly constricted at the septum, smooth, yellowish brown-colored, $43-62 \times 12-20\,\mu$; epispore thin ; pedicels short, brown or sub-hyaline, subdeciduous.

Hab. On *Glyceria aquatica* Sm.

Hokkaidō.—Prov. Ishikarî : Jōzankei (II. & III. Aug. 19, 1898. K. MIYABE ; II. & III. Aug. 24, 1898. T. NISHIDA) ; Shiroishi (II. & III. Oct. 6. 1907. S. ITŌ) ; Teine (II. & III. Oct. 25, 1907. S. ITŌ).

On *Glyceria tonglensis* Clk.

Shikoku.—Prov. Tosa : Kōchi (III. Jan. 2, 1907. S. KUSANO) ; Kamoda-mura (II. & III. Oct. 1907. T. YOSHINAGA).

Kiushū.—Prov. Higo : Kurokawa-mura (II. & III. Aug. 13, 1906. K. YOSHINO).

Distrib. Japan.

REMARKS. This species resembles closely *Puccinia Paniculariæ* Arth (1). which is parasitic on *Panicularia americana* (=*Glyceria grandis*) in North America. *Glyceria aquatica* and *G. tonglensis* (=*G. caspia* Trin.) are not recorded as the host-plants to the American species. In 1908, DIETEL (12), examining the specimen on *Glyceria tonglensis* sent by Mr. YOSHINAGA, recorded it as the same as the American species. By comparing the type specimen which Mr. YOSHINAGA had kindly sent me and many others with the description of *Puccinia Paniculariæ* I came to conclusion, that the Japanese and American plants are of two distinct species.

The points of difference are as follows :—

1. No record of the uredosori in the American species, the uredospores being found mixed within the teleutosori, but in our species the independent

uredosori are generally found on the opposite surface of leaves to the teleutosori, in which the uredospores are not found mixed.

2. The germ-pores of the uredospore are six in the American species, while in our species they are inconspicuous and most probably four.

3. The dimension of our uredospore is a little larger than that of the American species.

4. The teleutosori are recorded to be amphigenous, while ours are exclusively hypophyllous.

5. The teleutospores in our species are subcylindrical or cylindrical, while the American are oblong-clavate or clavate, sometimes sublinear.

6. The apex of the teleutospore is 5—6 μ thick in ours, while it is not or slightly thickened in the American.

7. The length of the teleutospore in ours measures 62 μ at its maximum, while 70 μ in the American species.

These differences will, I believe, sufficiently support the establishment of a new species of rust fungi.

16. Puccinia Elymi-sibiricæ S. Itō. n. sp.—(Pl. XI. Fig. 1.)

Uredosori, amphigenous, mostly epiphyllous; minute, oblong, scattered or gregarious, sometimes arranged in lines, naked, with the ruptured epidermis, pulverulent, dark orange-colored. Uredospores, globose, subglobose or ovate, verrucoso-echinulate, 28—32 × 20—22 μ; brownish yellow-colored; germ-pores 4; paraphyses absent.

Teleutosori, hypophyllous; minute, oblong, densely scattered over the surface, always covered by epidermis, blackish. Teleutospores cuneiform, cylindrical or clavate, apex truncate obliquely pointed or rounded, thickened (6—10 μ), base attenuated, not or slightly constricted at the septum, smooth, ferruginous, 36—70 × 18—22 μ; pedicels short, brown, subdeciduous. The sori are surrounded by a thick bed of brown paraphyses.

Hab. On *Elymus sibiricus* L.

Saghalien.—Nayashi (II. & III. Aug. 12, 1906, K. Miyabe & T. Miyabe).

Hokkaidō.—Prov. Shiribeshi: Oku-shiri (II. & III. July 27, 1890, K. Miyabe).

Distrib. Japan.

REMARKS. There are five species already recorded as parasitic on *Elymus*; namely, *Puccinia graminis*, *P. glumarum*, *P. montanensis*, *P. procrea* and *P. impatientis*. We need not discuss here differences of the present species and *P. graminis* and *P. montanensis*, because they differ from one another in many prominent points. *Puccinia glumarum*, *P. procrea* and *P. impatientis* are rather related to our species in the general shape of teleutospores. From *Puccinia glumarum*, it differs by having the uredospore, whose wall is brownish yellow in color, while it is hyaline or light yellow in *Puccinia glumarum*. From *P. procrea*, it differs in smaller uredospores, and teleutosori. In the former species, the uredospore is very large, and the teleutosorus is more remarkably so, measuring often 1 cm. in length, while in our species, the sorus is only 1.5 – 3 mm. in length. Moreover, the teleutospore of the former is larger than that of ours. From *P. impatientis* it differs in a fewer number of the germ-pores of uredospores and the teleutospore of this species is longer than that of others. As there are no species already described which correspond exactly with our species I may be justified in considering it as a new species.

17. Puccinia sessilis Schneid., in Schroeter, Brand und Rostpilze Schles. in Abhandl. d. Schles. Ges. naturw. Abt. 1869, (19); Winter, Pilze, 1884, (222): Schroeter, Pilz Schles., 1889, (324); Dietel, in Engl., Bot. Jahrb., **27.** 1900, (569); **32,** 1903, (48); **32,** 1903. (626); Henn., in Engl., Bot. Jahrb., **31,** 1902, (732); Sydow, Monogr. Ured., **1,** 1904, (781).

Hab. On *Phalaris arundinacea* L.

Saghalien.—Wendgishi (III. Aug. 18, 1906. K. MIYABE & T. MIYAGI); Makunkotan (III. Sept. 15, 1906. T. MIYAKE)

Hokkaidō.—Prov. Ishikari: Ebetsu (III. Sept. 29, 1907. S. ITŌ).

Honshū.—Prov. Tokyo (II. & III. Oct. 26, 1899; III. Sept. 2, 1900. S. KUSANO).

Kiushū.—Prov. Higo: Imizu-mura (II. May 15, 1904. S. YOSHINO).

Distrib. Europe, North America and Japan.

REMARKS. The present species was named by SCHNEIDER in 1891 but described by SCHROETER (1) in 1869. PLOWRIGHT, DIETEL and KLEBAHN have found in *Puccinia sessilis* many biological species by infection experiments; they are as follows: -

1. *Puccinia Iri-Phalaridis* (Plowr.) Kleb.
2. *P. Allii-Phalaridis* Kleb.

3. *P. Smilacearum-Digraphidis* Kleb.
4. *P. Paridi-Digraphidis* (Plowr.) Kleb.
5. *P. Schmidtiana* Diet.
6. *P. Convallariae-Digraphidis* (Sopp.) Kleb.
7. *P. Orchidearum-Phalaridis* Kleb.

In the absence of infection experiments, it is difficult to say to which of these seven biological species our plant belongs.

There are also in our country several aecidial forms on the same or related host-plants as those found in Europe, which have a relation with Puccinia on *Phalaris arundinacea*. They are Æcidia on *Convallaria Majalis*, *Majanthemum Convallaria*, *Polygonatum officinale*, *P. latifolium* var. *commutatum*, *P. humile*, *Paris quadrifolia* var. *obovata* and *Orchis aristata*. Besides these we have an Æcidium on *Trillium kamtschaticum* which is pretty near in its systematic position to *Paris*.

Comparing our Æcidia above mentioned to the description of the European species, I can hardly find any morphological difference between them. From this fact one may be inclined to divide our "*Puccinia sessilis*" into four following species, that is, *Puccinia Convallariae-Digraphidis*, *P. Smilacearum-Digraphidis*, *P. Paridi-Digraphidis* and *P. Orchidearum-Phalaridis*. But the following factors made me hesitate to treat them in that way.

1. Æcidium on *Convallaria Majalis* was collected in Saghalien by Mr. T. MIYAKE. He has a specimen of *Puccinia sp.* parasitic on the same host-plant, although it was collected in quite a different locality in the same island.

2. Æcidium on *Majanthemum Convallaria* occurs comparatively abundantly in our country. *Puccinia Majanthemi* Diet., a species peculiar to Japan, grows also on the same host-plant, very rarely accompanied by the Æcidium.

3. There is no record of infection experiment with the Æcidium on *Polygonatum latifolium* var. *commutatum* and *P. humile*.

4. *Paris quadrifolia* var. *obovata* is found abundantly in Hokkaidō, yet the Æcidium is very rarely found on it. I have collected it only once at Kuriyama, Prov. Ishikari. And I have failed to find *Phalaris arundinacea* in that vicinity.

All these relations remain unsettled so long as the infection experiments are not carefully performed. Meanwhile, I am compelled to adopt the old collective name of *Puccinia sessilis* in this paper.

18. Puccinia brachysora Diet. in Engl., Bot. Jahrb., **32,** 1903, (49); Sydow, Monogr. Ured., **1,** 1904, (737); Sacc., Syll., **17,** 1905, (383); Dietel, in Ann. Mycol., **5,** 1907, (73); **6,** 1908, (224).—(Pl. XI. Fig. 3.)

Hab. On *Brachypodium japonicum* Miq.

Honshū.—Prov. Musashi: Tokyo (II. & III. July 15, 1899. S. Kusano).

Shikoku.—Prov. Tosa: Jinzenji-mura (III. Sept. 1906. T. Yoshinaga).

Kiushū.—Prov. Higo: Kumamoto (III. June 15, 1906. K. Yoshino); Kawashiri-mura (III. June 10, 1906. K. Yoshino).

Distrib. Japan.

Remarks. Dietel (6) regarded this species to be a new one remarking on the shortness of the teleutosori, on their arrangement in lines and on the larger size of the uredospore.

From the related species *Puccinia himalensis*, this fungus may easily be distinguished by the absence of a crown at the apex of its teleutospore. From *Puccinia culmicola*, it is distinguished at once by the naked sori of the former.

Dietel (6) describes the uredosori as hypophyllous, and the teleutosori as epiphyllous; but by examining the same type specimen, I observed that uredosori are epiphyllous and the teleutosori are hypophyllous.

19. Puccinia Bromi-japonicae S. Ito. n. sp.—(Pl. XI. Fig. 4.)

Uredosori, epiphyllous; minute, oblong or linear, scattered or gregarious, often confluent, yellowish brown. Uredospores globose, subglobose or ellipsoidal, densely echinulate, yellowish, $22-30 \times 18-25\,\mu$; epispore thin; germ-pores numerous, inconspicuous; paraphyses absent.

Teleutosori, hypophyllous or on the sheath; small, oblong or linear, scattered or gregarious, often confluent, always covered by the epidermis, somewhat pulvinate, compact, conspicuous, blackish; surrounded by the thick bed of brown paraphyses. Teleutospores oblong-clavate, or oblong, apex thickened ($8-10\,\mu$), obtusely pointed or rounded, rarely

truncate, sometimes provided with an inconspicuous light-colored flattened papilla, base attenuated or rounded, more or less constricted at the septum, smooth, chestnut-brown, $34-54\times20-30\,\mu$; pedicels subhyaline or brownish, short, sometimes $30\,\mu$ in length, persistent.

Hab. On *Bromus japonicus* Th.

Hokkaidō.—Prov. Ishikari: Sapporo (II. & III. June 18, 1891. Y. TOKUBUCHI).

Distrib. Japan.

REMARKS. The present species differs from *Puccinia Symphyti-Bromorum* Müll. on *Bromus japonicus* and *B. pauciflorus* on many points.

The teleutospore of this species is sometimes provided at its obtusely pointed apex with a subhyaline flattened papilla-like protuberance which is often difficult to distinguish, while in *Puccinia Symphyti-Bromorum*, such a protuberance is entirely wanting. The size and general shape of the teleutospores are so conspicuously different in these two species, that I do not hesitate to consider our plant as a distinct new species.

β. Paraphyses present in uredosori.

20. Puccinia Poarum Niels. Bot. Tidsskr., **2**, 1877, (26); Winter, Pilze, 1884, (220); Sacc., Syll., **7**, 1888, (625); Schroeter, Pilz Schles., 1889, (326); Plowr., Brit. Ured. and Ustil., 1889, (168); Henn., in Engl., Bot. Jahrb., **28** 1901, (261); **31**, 1902, (732); Mayus, in Centralb. f. Bact. &c. II. **10**, 1903, (716); Klebahn, Wirtswechs. Rostpilze, 1904, (289); Sydow, Monogr. Ured., **1**, 1904. (795); Fischer, Ured. Schw., 1904, (361); McAlpine, Rusts of Australia, 1906, (128).

Hab. On *Poa annua* L.

Kurile Island.—Etorofu: Shana (II. July 29, 1884. K. MIYABE).

Hokkaidō.—Prov. Ishikari: Sapporo (II. May 20, 1891. N. HIRATSUKA & K. KIKUCHI; II. May 23, 1891; II. June 20, 1891; II. June 1894. II. June 8, 1897. K. MIYABE; II. June 11, 1898. T. KAWAKAMI; II. Oct. 1907. S. ITŌ).—Prov. Shiribeshi: Zenibako (II. June 11, 1891. Y. TOKUBUCHI).—Prov. Kitami: Rishiri-Island (II. July 21, 1899. T. KAWAKAMI).

Honshū.—Prov. Mutsu: Hirosaki (II. July 21, 1897. N. HIRATSUKA).—Prov. Rikuchū: Morioka (II. May 15, 1904. G. YAMADA; II. Nov. 23, 1905. K. SAWADA; II. May 3, 1897. Y. TAKAHASHI).—Prov. Musashi: Tokyo (II. April 28, 1902. N. NAMBU; II. July 1903. S. KUSANO).—Prov. Sagami: Hakone (II. April 12, 1901. K. MIYABE).

Kiushū.—Prov. Higo: Ōe-mura (II. April 11, 1907. H. MATSUO).

On *Poa acroleuca* Steud.

Honshū.—Prov. Shimotsuke: Nikkō (II. June 1898, M. SHIRAI).

Shikoku.—Prov. Tosa: Sakawa-machi (II. May 1901. T. YOSHINAGA).

Kiushū.—Prov. Higo: Sunatori-mura (II. May 26, 1904. K. YOSHINO); Kumamoto (II. April 26, 1907, T. NISHIDA).

On *Poa palustris* L.

Kiushū.—Prov. Higo: Kumamoto (II. May 26, 1904. K. YOSHINO).

On *Poa palustris* L. var. *strictula* Hack.

Honshū.—Prov. Musashi: Tokyo (II. June 5, 1902. N. NAMBU).—Prov. Echigo: Fukuto-mura (II. April 20, 1903. K. YOSHINO).

On *Poa pratensis* L.

Hokkaidō.—Prov. Ishikari: Sapporo (III. Oct. 6, 1894. K. MIYABE; II. July 21, 1895. K. MIYABE & Y. TOKUBUCHI; II. & III. Oct. 21, 1903. K. MIYABE; II. & III. Oct. 16, 1907; II. Oct. 20, 1907. S. ITO); Maruyama (II. Sept. 24, 1907. S. ITŌ).

On *Poa radula* Fr. et Sav.

Kurile-Island. Etorof: Setthamai (II. July 6, 1893. S. YOKOYAMA).

On *Poa viridis* Schreb. (cult.)

Hokkaidō.—Prov. Ishikari: Sapporo (II. & III. Oct. 16, 1907. S. ITŌ).

On *Deschampsia caespitosa* Beauv. (cult.)

Hokkaidō.—Prov. Ishikari: Sapporo (II. & III. Oct. 16, 1907. S. ITŌ).

On *Petasites japonicus* Miq.

Hokkaidō.—Prov. Ishikari: Sapporo (I. June 20, 1891; I. June 1896. K. MIYABE; I. June 11, 1895. N. HIRATSUKA; I. June 20, 1905. K. TACHIBANA); Toyohira-mura (I. May 1890. K. MIYABE); Kataishiyama (I. June 1, 1891. Y. TOKUBUCHI); Kabato (I. July 1890. I. SHIMIZU); Jōzankei (I. June 1906. S. ITŌ).—Prov. Iburi: Mororan (I. June 12, 1900. K. MIYABE).—Prov. Hitaka: Monbetsu (I. Aug. 16, 1907. M. Kasai).

Honshū.—Prov. Rikuchū: Sawa-mura (I. June 17, 1877. Y. TAKAHASHI).—Prov. Ugo: Matsumine (I. T. KAWAKAMI).—Prov. Uzen: Mt. Gwassan (I. Aug. 7, 1901. G. YAMADA); Mt. Yudono (I. Aug. 14, 1905. K. MIURA).—Prov. Izu: Mt. Amagi (I. May 10, 1897. S. HORI).—Prov. Hida: Arahara (I. May 20, 1899. YAMAGUCHI).

Shikoku.—Prov. Iyo: Myojin-mura (I. May 22, 1899. K. OKUDAIRA).

Distrib. Europe, North America, Japan and Australia.

REMARKS. *Æcidium Tussilaginis* Pers. was found to have a genetic relation to the present species by NIELSEN (2) in 1877. The connection was later verified experimentally by PLOWRIGHT, WINTER, KLEBAHN and TRANZCHEL.

According to SCHROETER, the Æcidium stage of this fungus occurs not only on *Tussilago Farfara* but also on *Petasites albus* and *P. officinalis*.

TRANZCHEL (1) asserts that Puccinia on *Poa nemoralis* has no connection whatever with the Æcidium on *Petasites officinalis*.

In our Flora, *Tussilago Farfara* is not present. On *Petasites japonicus*, however, the aecidial stage is very commonly found; and in the vicinity of such an infected plant, there occur frequently different species of *Poa* badly attacked by *Puccinia Poarum*. It is not unreasonable, therefore, to believe in this case in the possibility of the relationship existing between two forms of rust fungi. In our country, no infection experiments have yet been made to prove their genetic connection.

The Æcidium on *Petasites* in our country agree in general characters to that on *Tussilago* in Europe; and in the present paper, I have considered it provisionally as a stage of *Puccinia Poarum*.

I got, from Mr. T. MIYAKE, a Saghalien specimen of Æcidium on *Petasites japonicus*. It was found mixed with the sori of *Puccinia expansa* Link. But as *Puccinia expansa* belongs to Hemipuccinia, having no aecidial stage, and moreover as the Saghalien Æcidium coincides exactly with that of Hokkaido in their morphological character, it may well be regarded as a stage of *Puccinia Poarum* and not of *Puccinia expansa*.

The uredosori of *Puccinia Poarum* are distinguished from those of other related species by the presence of characteristic capitate paraphyses.

As it has been remarked by LAGERHEIM and CARLETON, the uredospores of this species hibernate also in our country. In Sapporo, on *Poa annua*, only the uredospores seem to be formed and the teleutospores so far have never been observed. The uredospores in this case are formed throughout the year from early spring to late autumn and even under the snow in winter.

The teleutospore of our plant is slightly larger than that of the European form; but in other points they agree exactly.

In 1903, DIETEL (7) regarded the Uredo on *Poa pratensis*, collected by Mr. NAMBU at Nishigahara, as a different species from that of the present plant. I have no specimen in my hand which correspond to DIETEL's description.

I have collected in our Botanical Garden a species of Puccinia, much resembling the present species, on *Deschampsia caespitosa*, introduced by

seed from Dublany. The species of Puccinia known to infect *Aira* (*Deschampsia*) are *Puccinia graminis*, *P. coronata*, *P. borealis* and *P. Baryi*. All these species, however, do not agree with our fungus which on the contrary resembles very closely *Puccinia Poarum* and is here provisionally placed in the species under consideration.

21. Puccinia ishikariensis S. Ito. n. sp.—(Pl. XI. Fig. 6.)

Uredosori, epiphyllous; oblong or linear, minute, on the brownish discolored spots, gregarious, often confluent, immersed between the veins, naked, pulverulent, brown-colored. Uredospores, globose, sublobose or piriform, echinulate (distance between spines about 3 μ), yellow or brownish yellow in color, $20-36 \times 14-28\ \mu$; epispore $2-3\ \mu$ thick; germ-pores 6—8, scattered; paraphyses numerous, clavate or capitate, apex not thickened, yellowish, $50-80 \times 17-18\ \mu$.

Teleutosori, amphigenous; small, oblong or linear, densely scattered over the surface, arranged in lines, rarely confluent, long covered by the epidermis, at length naked, with the torn remains, compact, somewhat pulvinate, grey or black; surrounded by the thick bed of brown paraphyses. Uredospores are frequently mixed in the sori. Teleutospores, cylindrical, cuneate or oblong-clavate, unsymmetrical, apex thickened (4—6 μ), truncate, rounded or shortly apiculate, base attenuated or cuneate, not or slightly constricted at the septum, smooth, brownish-orange, lighter colored at the lower cell, $36-60 \times 14-24\ \mu$; epispore thin; pedicels short, brown, subdeciduous.

Hab. On *Molinia japonica* Hack.

Hokkaidō.—Prov. Ishikari: Tsuishikari (II. Sept. 29, 1907. S. Irō; II. & III. Oct. 6, 1907. M. Kasai).

Distrib. Japan.

Remarks. The species of Puccinia hitherto known to grow on *Molinia* are *Puccinia graminis*, *P. coronata*, *P. Moliniae*, *P. Diplachnis* and *P. australis*.

Except the one last mentioned all other species occur in Japan, and they differ entirely from the present species. Our plant differs also from *Puccinia australis*. It is distinguished from *Puccinia coronata* by the

absence of the crown, and from the other remaining species it differs by the sorus long covered by epidermis.

The shape of the teleutospores approaches nearest to that of *Puccinia glumarum* from which our plant can easily be distinguished by the uredosori provided with numerous clavate paraphyses. This fungus is often found mixed with *Puccinia Moliniae* on the same leaf of the host-plant.

22. Puccinia Ishikawai S. Ito n. sp.—(Pl. XI. Fig. 5)

Uredosori, amphigenous; very minute, oblong, scattered, on the discolored spots, often arranged in lines, sometimes confluent, loosely covered by the epidermis or naked, somewhat pulvinate, orange-colored. Uredospores, globose or subglobose, rarely broadly ellipsoidal, finely echinulate, $22-32\times20-28\,\mu$; epispore hyaline or yellowish; paraphyses numerous, clavate, membrane thickened, hyaline, apex not thickened, $40-80\times11-16\mu$.

Teleutosori, hypophyllous; very minute, oblong or linear, scattered or subgregarious, arranged in lines, sometimes confluent, long covered by the epidermis, somewhat pulvinate, grey or blackish. Teleutospores, clavate, oblong-clavate or cuneate, apex truncate, obliquely pointed or wavy, thickened ($4-6\,\mu$), base mostly attenuated, not or slightly constricted at the septum, rusty or light brown, darker colored at apex, $28-48\times12-20\,\mu$, rarely $22\,\mu$ in width; epispore thin; pedicels short, brown, subdeciduous.

Hab. On *Calamagrostis Epigejos* Roth. var. *densiflora* Led.

Hokkaidō.—Prov. Ishikari: Kotoni (III. July 26, 1901. K. Miyabe); Tsuishikari (II. & III. Sept. 21, 1902. G. Yamada; II. & III. Sept. 29, 1907. S. Itō); Shiroishi (II. & III. Oct. 6, 1907. S. Itō); Asahigawa (II. & III. Oct. 8, 1907. S. Itō); Iwamizawa (II. Oct. 10, 1907. S. Itō).—Prov. Kitami: Sarubutogawa (III. Oct. 1892. T. Ishikawa); Rishiri-Island (II. & III. Aug. 15, 1907. M. Miura).

Distrib. Japan.

Remarks. The present species resembles closely *Puccinia pygmaea* Eriks. in general characters. But they can easily be distinguished from each other by the color of the pedicel of the teleutospore. In *Puccinia pygmaea* the pedical is hyaline, while in our species it is brown.

γ. Uredostage not yet found.

23. Puccinia fujiensis S. Itō. n. sp.—(Pl. XI. Fig, 7.)

Teleutosori, hypophyllous; small, oblong or linear, scattered or subgregarious, often confluent, always covered by the epidermis, conspicuous,

blackish; surrounded by the brown paraphyses. Teleutospores, cylindrical or oblong-clavate, apex truncate or obliquely pointed, slightly thickened (4—8 μ), base attenuated or angular, not or slightly constricted at the septum, smooth, ferruginous, 44—58 × 15—17 μ; epispore thin; pedicels short, brown, subdeciduous.

Hab. On *Anthoxanthum japonicum* Hack.

Honshū.—Prov. Suruga: Mt. Fuji (III. July 21, 1881. J. MATSUMURA).

Distrib. Japan.

REMARKS. There are two species of Puccinia which have been known to grow on *Anthoxanthum*. They are *Puccinia Anthoxanthi* Fuck. and *P. borealis* Juel. *Puccinia Anthoxanthi* of Europe is distinguished macroscopically from the present species by its naked sorus. From *Puccinia borealis* of America it differs in the form and size of the teleutospores. In *P. borealis* the spore is clavate or subclavate, and smaller (35—45 × 13—20 μ).

This species approaches in its spore-shape to *Puccinia dispersa*. But the attenuation of the lower cell of the teleutospore in this species is not so abrupt as in the latter species. The general form of the spore is rather cylindrical than oblong-clavate in our species. Its septum is located in a lower position than that of *P. dispersa*.

I have not yet seen any specimen of its uredostage, which I believe will be found after a careful search. This fact makes the identification still more difficult. At any rate, the points of difference from the related species, which I have discussed, would justify us in considering this plant as a new species.

b. Teleutosorus naked.

24. Puccinia graminis Pers., Ten. Disp. Meth. Fung., 1797, (39); Winter, Pilze, 1884, (217); Burrill, Parasitic Fungi of Ill. 1885, (197); Sacc., Syll., **7,** 1888, (622); Schroeter, Pilz Schles., 1889, (322); Plowr., Brit. Ured. and Ustil., 1889, (162); Eriks. u. Henn., Die Getreideroste, 1896, (25); Eriks., Centralb. f. Bact. &c. II, **9,** 1902, (590); Henn., Engl., Bot. Jahrb., **31,** 1902, (731); Sydow, Monogr. Ured., **1,** 1904, (692); Fischer, Ured. Schw., 1904, (243); Dietel, Engl., Bot. Jahrb., **34,** 1905, (585); McAlpine, Rusts of Australia, 1906, (120); Butler and Hayman, Mem. of the Depart. of Agric. in India, **1,** 1906, (27); Takahashi, Trans. Sap. Nat. Hist. Soc., **1,** 1906, (41).

Hab. On *Agrostis alba* L.

Hokkaidō.—Prov. Ishikari: Iwamizawa (II. Sept. 10, 1907. S. Itō); Yamahana (II. Sept. 15, 1907. S. Itō); Garugawa (II. Sept. 22, 1907. S. Itō); Tsuishikari (II. & III. Sept. 29, 1907. S. Itō); Shiroishi (II. Oct. 6, 1907. S. Itō); Nagayama (II. Oct. 7, 1907. S. Itō); Sapporo (II. & III. Oct. 11, 1907; Oct. 20, 1907. S. Itō).

Honshū.—Prov. Rikuchū: Morioka (II. Sept. 12, 1906. G. Yamada).

On *Agrostis canina* L. (cult.)

Hokkaidō.—Prov. Ishikari: Sapporo (II. & III. Oct. 20, 1906. S. Itō).

On *Agrostis stolonifera* L. (cult.)

Hokkaidō.—Prov. Ishikari: Sapporo (II. & III. Oct. 20, 1906. S. Itō).

On *Avena chinensis* Hort. (cult.)

Hokkaidō.—Prov. Ishikari: Sapporo (III. Oct. 16, 1906. M. Miura).

On *Avena sativa* L.

Hokkaidō.—Prov. Ishikari: Sapporo (II. Sept. 12, 1903. T. Miyake).

On *Avena sterilis* L. (cult.)

Hokkaidō.—Prov. Ishikari: Sapporo (II. Oct. 1907. S. Itō).

On *Avena strigosa* Schreb. (cult.)

Hokkaidō.—Prov. Ishikari: Sapporo (II. Oct. 1907. S. Itō).

On *Hordeum sativum* Jessen.

Hokkaidō.—Prov. Ishikari: Sapporo (II. & III. Sept. 14, 1905. K. Miyabe & J. Hanzawa)

Honshū.—Prov. Uzen: Yamagata (III. Nov. 10, 1907. S. Murayama).

On *Triticum monococcum* L. (cult.)

Hokkaidō.—Prov. Ishikari: Sapporo (III. Sept. 1902; II. & III. Nov. 5, 1903. T. Miyake)

On *Triticum vulgare* Vill.

Saghalien.—Ūgorinuepadji (III. Oct. 12, 1906. T. Miyake).

Hokkaidō.—Prov. Ishikari: Shiroishi (III. Aug. 25, 1894. N. Hiratsuka); Sapporo (III. Oct 12, 1907. S. Itō); Tsuishikari (II. Sept. 29, 1907. S. Itō); Ebetsu (III. Sept. 29, 1907. S. Itō).

Honshū.—Prov. Rikuchū: Morioka (II. & III. July 21, 1901. G. Yamada).—Prov. Settsu: Ōsaka (III. Sept. 1906. A. Ideta).—Prov. Echigo: Yoshida-mura (III. July 23, 1908. S. Itō); Tsubame (II. & III. July 26, 1908. S. Itō).

Kiushū.—Prov. Higo: Kumamoto (II. June 2, 1907. T. Nishida; III. May 7, 1905. K. Yoshino & S. Maihara; II. & III. June 19, 1904. K. Yoshino).

Formosa.—Ensuikō (II. 1907. T. Kawakami); Daihoku (II. & III. 1907. T. Kawakami & R. Suzuki).

On *Berberis vulgaris* L.

Hokkaidō.—Prov. Ishikari: Sapporo (I. June 2, 1890. K. Miyabe).—Prov. Oshima: Hakodate (I. July 10, 1890. K. Miyabe).—Prov. Hitaka (I. June 1884. K. Miyabe).—Prov. Shiribeshi Isoya (I. July 18, 1888. K. Miyabe).

Honshū.—Prov. Echigo: Mt Tohō (I. Aug. 12, 1908. S. Itō).

Distrib. Asia, Africa, Europe, America and Australia.

REMARKS. The "black rust," as the present species is popularly called, was known from ancient times in several countries. Naturally the works on this species are numerous, but those cited above are the most important concerning its classification.

In 1865, the Æcidium on *Berberis* was for the first time proved scientifically by DE BARY as a stage in the life cycle of this species. This is the beginning of our knowledge on heteroecism. J. ERIKSSON and E. HENNING (2) studied this species quite exhaustively and enumerated as its host-plant the names of 109 species of grasses. He (6) classified this species as the result of his own infection experiments into the following specialized forms :—

1. *f. sp. Secalis.*
2. *f. sp. Tritici.*
3. *f. sp. Avenae.*
4. *f. sp. Airae.*
5. *f. sp. Agrostis.*
6. *f. sp. Poae.*

However, in North America, CARLETON (1) found only the following two specialized forms well established; namely, 1. *f. sp. Tritici* and 2. *f. sp. Avenae.*

In our country, barley, oats, wheat and *Agrostis* are known as the host-plants of this fungus. Especially wheat seems to be most severly attacked.

25. Puccinia kozukensis Diet., in Engl., Bot. Jahrb., **32,** 1903, (48); Sydow, Monogr. Ured., **1,** 1904, (721); Sacc., Syll., **17,** 1905, (379).

Hab. On *Andropogon micranthus* Kth.

Honshū.—Prov. Kōzuke: Mt. Myogi (III. Nov. 4, 1899. S. KUSANO).—Prov. Hitachi (III. Oct. 11, 1900).—Prov. Ugo: Akita (III. Nov. 1903. Y. TOKUBUCHI).

Distrib. Japan.

REMARKS. As has been well remarked by DIETEL (6), the present species is very easily distinguished from other species of Puccinia on *Andropogon* by the roundish form of its teleutospore, and also by the thinner epispore of its lower cell.

26. Puccinia Nakanishikii Diet. in Engl., Bot. Jahrb., **34,** 1905, (585); **37,** 1906, (101); Sydow & Butler, in Ann. Mycol., **4,** 1906, (435).—(Pl. XI. Fig. 10).

Syn.: *Puccinia purpurea* P. Henn. in Engl., Bot. Jahrb., **28,** 1901, (261).

Hab. On *Andropogon Nardus* L. var. *Gœringii* Hack.

Honshū.—Prov. Musashi: Kōnodai (II. Oct. 15, 1904. S. KUSANO).—Prov. Awa: Mt. Nokogiri (III. Oct. 21, 1882. K. MIYABE).

Shikoku.—Prov. Tosa: Mt. Washio (II. Oct. 1903. NAKANISHIKI); Engyoji (II. Oct. 1907. T. YOSHINAGA).

Distrib. Japan and India.

REMARKS. I agree with DIETEL (8) in his view as to the wide variation in color (from light brown to deep chestnut-brown) of the paraphyses, and also as to the deeper color of the pedicel at its upper portion.

The teleutosori of this species have never described. I was able, however, to observe that stage, on the specimen collected by Prof. K. MIYABE in 1882 at Mt. Nokogiri, Prov. Awa. The teleutosori are hypophyllous, small, oblong or linear on brownish discolored spots, and are scattered or gregarious, sometimes confluent. They are naked, with torn epidermis, somewhat pulvinate, and blakish chestnut-brown in color.

In 1906, SYDOW and BUTLER (1) reported this species to be parasitic on the same host-plant in India and they have noted that the teleutospore of the Indian species has a thicker wall than that of the Japanese species.

27. Puccinia purpurea Cke. in Grevillea, 5, 1876, (15); Sacc., Syll., **7,** 1888, (657); Barclay, Journ. of Bot., **28,** 1890, (257); Busse, Ber. Deutsch. Bot. Ges., **20,** 1902, (283); Arb. aus. d. Biol. Abt. f. Land. u. Forstw. am Kaiserl. Gesundh., **4,** 1904, (319); Zimmermann, Berichte ü. Land u. Forstw. in Deut. Ostafrika, **2,** 1904, (15); Sydow, Monogr. Ured., **1,** 1904, (803); McAlpine, Rusts of Australia, 1906, (129); Takahashi, Trans. Sap. Nat. Hist. Soc., **1,** 1907, (8).

Hab. On *Andropogon Sorghum* Brot. var. *vulgaris* Hack.

Kiushū.—Prov. Higo: Ōemura (II. & III. Sept. 29, 1905. K. YOSHINO).

Formosa.—Daihoku: Kawayashiki (II. Dec. 2, 1906. R. SUZUKI).

Distrib. Asia, Africa and Europe.

REMARKS. BUSSE (1. 2.) described this species most fully in his papers on sorghum-rust in German East Africa, and supplemented thereby the incomplete description of COOKE (1).

The host-plants of this species hitherto known are *Andropogon Sorghum*, *A. Halepensis*, *Zea Mays* and *Pennisetum typhoideum*. The occurrence of this rust fungus on the first mentioned host-plant in our country, P. HENNINGS (1) asserts by examining the specimen collected in Tokyo, but DIETEL (8) is of opinion that *Puccinia purpurea* of P. HENNINGS may not be different from his *Puccinia Nakanishikii*.

28. Puccinia Arundinellae anomalae Diet. in Engl., Bot. Jahrb., **37**, 1906, (100); in Ann. Mycol., **5**, 1907, (73).—(Pl. XI. Fig. 11.)

Syn.: *Puccinia graminis* Diet. in Engl., Bot. Jahrb., **32**, 1903, (48).

Hab. On *Arundinella anomala* Steud.

Hokkaidō.—Prov. Oshima: Zenikamezawa (III. Oct. 12, 1900. T. KAWAKAMI; III. 1896.)—Prov. Ishikari: Gārugawa (III. Sept. 22, 1907. S. IRŌ).

Honshū.—Prov. Kōzuke: Mt. Myogi (III. Nov. 4, 1899. S. KUSANO).—Prov. Musashi: Tsurumi (III. Oct. 26, 1904. N. NAMBU); Tokyo (III. Sept. 1904. M. SHIRAI; II. & III. Oct. 24, 1904. S. KUSANO); Nishigahara (II. & III. April 17, 1899. S. HORI).

Shikoku.—Prov. Tosa: Tōchi-mura (III. Sept. 1906; III. Oct. 1906. T. YOSHINAGA).

Kiushū.—Prov. Higo: Mt. Aso (III. Oct. 12, 1905. K. YOSHINO); Yamauchi-mura (III. Nov. 3, 1906. K. YOSHINO).—Prov. Bungo: Sugō-mura (III. Sept. 4, 1905. K. YOSHINO).

Distrib. Japan, China and Siberia.

REMARKS. DIETEL (9) regarded this species as a new one, separating it from *Puccinia Arundinellae* Barcl., by its slender teleutospores. He based this determination on the specimen collected by Prof. S. KUSANO in Tokyo in 1904.

Previous to this period DIETEL (6) identified the specimen on the same host-plant collected by Prof. S. KUSANO in 1899 at Mt. Myogi, Prov. Kōzuke, to be *Puccinia graminis*.

In 1902, P. HENNINGS (3) also noticed the occurrence of *Puccinia graminis* on *Arundinella anomala*, which was collected by Mr. T. YOSHINAGA in 1901, at Akatouchi-toge, Prov. Tosa.

Thus according to the European authorities, there seem to exist two

species of Puccinia in our country on *Arundinella anomala*. On this point, I have sufficient reason to doubt its validity.

I obtained, by the kindness of Prof. S. KUSANO, both of the type specimens on which DIETEL based his determination. In the course of my study on both of these type specimens, my attention was drawn to the similarity between them. The pedicel of *Puccinia Arundinellae anomalae* is hyaline or light brownish yellow in color; while that of *Puccinia graminis* is also light brownish or sometimes hyaline. Thus, to distinguish them by the color of the pedicel becomes totally impossible.

The color of the pedicel is not an essential factor in the point of classification in Puccinia, at least, it is true in the case of Puccinia on Gramineae. For example, the pedicels of *Puccinia erythropus*, *P. rufipes*, *P. Eulaliae* and *P. Arundinellae* and also those of many other species vary pretty often in their color. So, simply from the color difference of the pedicels the so called *Puccinia graminis* on *Arundinella* may not be different from PERSOON'S *Puccinia graminis*. But uredospores which were accidentally found on the type specimen of the so called *Puccinia graminis*, differ utterly from those of *P. graminis*, but correspond exactly to those of the present species. I wish, for the reasons above mentioned, to include the Myogi specimen in *Puccinia Arundinellae anomalae*.

As has already been mentioned, this species is distinguished from *Puccinia Arundinellae* of Himalaya by the slender teleutospores. But it must be remenbered that the dimensions of some of our species approach that of *P. Arundinellae*. Among specimens, collected at Garugawa, Tsurumi and other places, there were few spores which measure above 42 μ. Generally, while young, the color of the teleutospore is light colored and slender in shape, but when ripened its color is darker and more or less roundish in shape. After all, our species may not be different from the Himalayan species. Further study is needed to settle this point.

29. Puccinia culmicola Diet. in Engl., Bot. Jahrb., **37,** 1906, (100).—(Pl. XI. Figs. 8, 9.)

Hab. On *Brachypodium japonicum* Miq.

Honshū.—Prov. Musashi: Komaba (II. & III. Sept. 18, 1900. S. KUSANO).

On *Agropyrum semicostatum* Nees?

Honshū.—Prov. Rikuchū: Morioka (III. Nov. 12, 1905. G. YAMADA).

Distrib. Japan.

REMARKS. DIETEL (9) described this species from the specimen collected by Prof. S. KUSANO in Tokyo. It differs from other Puccinia on *Brachypodium* by the naked teleutosori and non-coronate teleutospores and by the invariable occurrence of the sori on the culm.

I have found among the specimens sent to me from Prof. G. YAMADA, a species of Puccinia on *Agropyrum semicostatum?* which coincides closely with the type specimen of this species on *Brachypodium.*

30. Puccinia stichosora Diet., in Engl., Bot. Jahrb., **37,** 1906, (100).

Hab. On *Calamagrostis arundinacea* Roth. var. *sciuroides* Hack.

Honshū.—Prov. Musashi: Tokyo (II. Sept. 15, 1904. N. NAMBU).

Distrib. Japan.

REMARKS. By the kindness of Mr. N. NAMBU, I have been able to examine the type specimen of this species in its uredostage. The uredospores of this species differ from those on *Calamagrostis* by the darker color of their epispore.

31. Puccinia Cynodontis Desm. Exs. **3,** no 655; Winter, Pilze, 1884, (180); Sacc., Syll., **7,** 1888, (661); Magnus, in Verhandl. Zool. bot. Ges., **49,** 1899, (95); Sydow, Monogr. Ured., **1,** 1904, (748); McAlpine, Rusts of Australia, 1906, (118).

Syn.: *Puccinia varians* Diet., in Ann. Mycol., **6,** 1908, (224).

Hab. On *Cynodon Dactylon* Pers.

Honshū.—Prov. Musashi: Tokyo (II. Nov. 1899. M. SHIRAI; III. Oct. 20, 1904. S. KUSANO). —Prov. Echigo: Yoshida (III. Aug. 18, 1908. S. ITO).

Shikoku.—Prov. Tosa: Kōchi (III. Nov. 1906. T. YOSHINAGA),

Distrib. Europe, Asia and Africa.

REMARKS. No account concerning the occurrence of this species in our country, except a short note by Prof. S. KUSANO (2), has yet been published.

In 1899, P. MAGNUS (2) remarked that there are two kinds of uredospores in this species. One kind has a thin echinulate wall with numerous germ-pores (to 9) located at the upper portion of the spore. Another kind

has a smooth or scarcely echinulate wall with a few germpores (1-3). However, according to him, there are transitional forms between these two kinds. I have observed only the latter kind of uredospores in Japanese specimens.

Lately, W. TRANZCHEL (2) proved the genetic relation of the present species by infection experiments to *Æcidium Plantaginis* on *Plantago lanceolata* in Russia. At about same time, Fr. Bubák (1) also obtained the similar results, but he failed to prove the relationship of the Æcidia on *Plantago major*, *P. media*, *P. Cynops* and *P. Psyllum* with this species. *Æcidium Plantaginis* on *Plantago major* occurs very commonly in our country, but Æcidium on *Plantago lanceolata* is not yet found.

In 1908, DIETEL (12) described this fungus sent from Japan as a new species under the name of *Puccinia varians*. His description correspond closely that of *Puccinia Cynodontis*, but he did not give any remarks on the affinity with the latter species.

32. **Puccinia Diplachnis** Arth. in Bull. Torr. Bot. Club, **31,** 1904, (4); Sydow, Monogr. Ured., **1,** 1904, (900); Sacc., Syll., **17,** 1905, (383); Kusano, Bot. Mag. Tokyo, **18,** 1904, (148).

Hab. On *Diplachne serotia* Link. var. *aristata* Hack.

Honshū.—Prov. Musashi: Tokyo (II. & III. Nov. 8, 1904. S. KUSANO).

Distrib. North America and Japan.

REMARKS. Prof. S. KUSANO (1) identified the present species to *Puccinia Diplachnis* of North America.

33. **Puccinia rufipes** Diet. in Engl., Bot. Jahrb., **32,** 1903, (48); Ann. Mycol., **5,** 1907, (73); Sydow, Monogr. Ured., **1,** 1904, (757); Sacc., Syll., **17,** 1905, (377).

Hab. On *Imperata arundinacea* Cyr. var. *Koenigii* Hack.

Honshū.—Prov. Musashi: Itabashi (III. Oct. 10, 1895, S. HORI); Tokyo (III. Sept. 28, 1899; II. & III. Oct. 28, 1899; III. Sept. 24, 1904. S. KUSANO; III. Oct. 26, 1899. T. NISHIDA); Ōmiya (III. Nov. 20, 1899. T. NISHIDA); Nakano (III. Nov. 20, 1900. N. NAMBU); Awoyama (III. Nov. 1901. K YOSHINO).

Shikoku.—Prov. Tosa (II. 1901. T. YOSHINAGA).

Distrib. Japan.

REMARKS. The characteristic of the present species is, as its specific name indicates, a deep reddish color of pedicels of its teleutospores.

This is one of the two species of Puccinia hitherto known to be parasitic on *Imperata arundinacea* var. *Koenigii*, another species being *Puccinia Eulaliae*.

According to my own observations, the maximum length of its teleutospores is 42 μ, while DIETEL (6) limitted it to 33 μ.

34. Puccinia erythropus Diet. in Engl., Bot. Jahrb., **37**, 1906, (101); Ann. Mycol., **6**, 1908, (224).—(Pl. XI. Fig. 12).

Hab. On *Miscanthus sinensis* Anders.

Hokkaidō.—Prov. Ishikari: Sapporo (III. Oct. 28, 1895; III. Oct. 1895. Y. TOKUBUCHI); Maruyama (III. Sept. 9, 1895, N. HIRATSUKA & K. KIKUCHI; III. Oct. 3, 1902. K. MIYABE); Mt. Moiwa (III. Sept. 24, 1901; III. Oct. 24, 1901; III. Oct. 28, 1901. G. YAMADA; III. Oct. 19, 1903. K. MIYABE; III. Oct. 11, 1903. J. HANZAWA); Garugawa (III. May 21, 1899. K. MIYABE; III. Oct. 24, 1905. J. HANZAWA & S. ITO); Tsuishikari (III. Sept. 29, 1907. S. ITO; III. Oct. 6, 1907. M. KASAI); Ishiyama (III. Oct. 11, 1905. J. HANZAWA); Barato (III. Oct. 24, 1897. T. NISHIDA); Horomui (III. Oct. 1891; III. Sept. 22, 1894. Y. TOKUBUCHI); Ikushunbetsu (III. Oct. 1, 1902. T. MIYAKE).—Prov. Shiribeshi: Raiden-tōge (III. Oct. 6, 1901. G. YAMADA); Tsukigoe (III. Oct. 24, 1905. R. OGAWA); Shikuzushi (III Oct. 13, 1903. K. MIYABE).—Prov. Oshima: Junsainuma (III. Sept. 27, 1899. K. MIYABE).

Honshū.—Prov. Rikuchū: Morioka (III. Oct. 28, 1906. K. OKUMURA).—Prov. Uzen: Akita (III. Nov. 1903. Y. TOKUBUCHI).—Prov. Musashi: Komaba (III. Oct. 20, 1895. K. SENGOKU; II. Nov. 1899. M. SHIRAI).

Shikoku.—Prov. Tosa: Umaji-mura (III. Oct. 1904. T. YOSHINAGA); Sakanoue (III. Oct. 1904. T. YOSHINAGA); Ōsakayama (III. Sept. 1906. T. YOSHINAGA).—Prov. Iyo: Minamiuwa-gun (II. 27, 1907. T. NISHIDA); Aratachi (III. Nov. 20, 1906. T. NISHIDA).

Kiushū.—Prov. Higo: Mt. Aso (III. Oct. 12, 1905. K. YOSHINO).

On *Miscanthus sacchariflorus* Hack.

Honshū.—Prov. Echigo: Santō-gun (III. Dec. 15, 1903. K. YOSHINO).

Distrib. Japan.

REMARKS. Comparing the specimens of this fungus with the description by DIETEL, I feel it necessary to make the two following remarks.

1. Although in the original description of the present species by DIETEL, the sorus is said to be epiphyllous, my own observation shows, the fact to be just the opposite. The type specimen as well as all other specimens I have examined present invariably the hypophyllous sori.

2. In regard to the size of the uredospore, there are some differences

between his statement and my own actural measurements (28-34 × 20-25 μ), mine being a little larger.

In 1908, the same author (12) wrote that this fungus grows also on *Calamagrostis sciuroides* Fr. et Sav. But I have not yet found any specimen of *Calamagrostis* bearing this parasite and I hesitate, at any rate, to accept his statement.

A criterion, by which we can easily distinguish it from other species, is the wider diameter of the lower cell of the teleutospore at the portion just below the septum.

35. **Puccinia Eulaliae** Barcl., in Journ. Asiatic Soc. Bengal, **60**, 1891, (216); Sacc., Syll., **11**, 1895, (199); Henn., in Engl., Bot. Jahrb., **31**, 1902, (732); Dietel, in Engl., Bot. Jahrb., **27**, 1900, (569); **32**, 1903, (48); **32**, 1903, (625); Sydow, Monogr. Ured., **1**, 1904, (797).

Hab. On *Miscanthus sinensis* Anders.

Hokkaidō.—Prov. Ishikari: Okatama-mura (III. Nov. 23, 1890. K. MIYABE); Horomui (III. Oct. 1892. Y. TOKUBUCHI); Maruyama (III. Sept. 9, 1895. N. HIRATSUKA & K. KIKUCHI); Sapporo (III. Oct. 28, 1895. Y. TOKUBUCHI); Tsuishikari (III. Sept. 21, 1902. G. YAMADA; III. Sept. 29, 1907. S. ITŌ); Mt. Moiwa (II. & III. Aug. 18, 1907. S. ITŌ); Ishiyama (III. Oct. 11, 1905. K. MIYABE); Shiroishi (III. Oct. 6, 1907. S. ITŌ); Nagayama (III. Oct. 7, 1907. S. ITŌ).—Prov. Iburi: Abuta (II. Aug. 17, 1897. T. NISHIDA); Chitose (III. Oct. 10, 1900. G. YAMADA).—Prov. Oshima: Zenikamezawa (III. Oct. 12, 1900. T. KAWAKAMI); Okushiri-Island (III. Nov. 3, 1900. T. KAWAKAMI).—Prov. Kitami: Rishiri-Island (III. Sept. 2, 1899. T. KAWAKAMI; III. Aug. 20, 1907. M. MIURA).

Honshū.—Prov. Rikuchū: Morioka (II. & III. Oct. 17, 1907. G. YAMADA).—Prov. Musashi: Tokyo (III. Oct. 15, 1891. S. HORI; III. Nov. 25, 1898. M. MIYOSHI; II. & III. Oct. 28, 1899. S. KUSANO; III. Nov. 20, 1899. T. NISHIDA; III. Sept. 18, 1900. S. KUSANO; II. Oct. 18, 1900. T. FUKUHARA; II. & III. Nov. 14, 1901. K. YOSHINO; III. Nov. 9, 1904. N. NAMBU).—Prov. Echigo: Yahiko (II. July 23, 1908. S. ITŌ);- Mazetōge (II. Aug. 9, 1908. S. ITŌ); Mt. Yahiko (II. Aug. 12, 1908. S. ITŌ); Mt. Kanazu (II. Aug. 19, 1908. S. ITŌ).—Prov. Sagami: Mitaki (II. Aug. 24, 1900. G. YAMADA).—Prov. Mino: Mt. Kinkwa (III. Nov. 10, 1898. Y. TOKUBUCHI).—Prov. Suwō: Yamaguchi (III. Sept. 1903. A. IDETA).

Kiushū.—Prov. Higo: Mt. Aso (II. Oct. 12, 1905; III. Oct. 13, 1905. K. YOSHINO).—Prov. Bungo: Ōita (II. June 1905. K. YOSHINO); Miemachi (II. June 15, 1905. K. YOSHINO).

Formosa.—Daihoku: Tansui (II. Jan. 4, 1907. R. SUZUKI).

On *Miscanthus Sacchariflorus* Hack.

Honshū.—Prov. Musashi Kami-itabashi (III Oct. 29, 1904. S. KUSANO).—Prov. Echigo: Yoshida (II. Aug. 10, 1908. S. ITŌ); Mt. Gomadō (II. Aug. 20, 1908. S. ITŌ).

On *Miscanthus condensatus* Hack.

Honshū.—Prov. Musashi: Tokyo (III. Oct. 26, 1899. S. KUSANO).

On *Miscanthus sp.*

Honshū.—Prov. Mutsu : Goshogawara (III. Oct. 1904. T. KASHIWAI).

Distrib. Japan and India.

REMARKS. BARCLAY (3) tells nothing of the uredosori of this fungus ; and his descriptions of the uredospores are made from those mixed in the teleutosori. Uredosori of this species are hypophyllous, small, roundish, oblong or linear in form, scattered or subgregarious on a characteristic dark reddish spot, often confluent (6 mm in length), naked, with torn epidermis on their margins, pulverulent, and brown in color.

According to DIETEL (7), this fungus grows also on the leaves of *Imperata arundinacea*, in which case the uredospores are said to be slightly smaller than those on *Miscanthus sinensis*. I have not been able so far to find the present species on *Imperata arundinacea*. Besides these two host-plants, two other species are added in this paper, namely *Miscanthus sacchariflorus* and *M. condensatus*.

36. Puccinia Moliniae Tul. in Ann. Sc. nat. soc., 6 s. **2,** 1854, (141) ; Winter, Pilze, 1884, (219) ; Sacc., Syll., **7,** 1888, (631) ; Plowr., Brit. Ured. and Ustil., 1889, (179) ; Schroeter, Pilz Schles., 1889, (332) ; Klebahn, in Zeits. f. Pflanzenk., **4,** 1894, (138) ; **6,** 1896, (268) ; **9,** 1899, (156) ; Sydow, Monogr. Ured., **1,** 1904, (762) ; Fischer, Ured. Schw., 1904, (256).

Hab. On *Molinia japonica* Hack.

Hokkaidō.—Prov. Oshima : Oshamanbe (III. Aug. 11, 1892. T. KAWAKAMI).—Prov. Ishikari : Horomui (III. Sept. 21, 1894. Y. TOKUBUCHI) ; Tsuishikari (III. Sept. 21, 1902. G. YAMADA ; III. Sept. 29, 1907. S. ITŌ ; III. Oct. 6, 1907. M. KASAI) ; Chasinai (III. Oct. 10, 1908. J. IKEDA).

Distrib. Europe and Japan.

REMARKS. I have not able to find any uredosorus of this fungus in Hokkaido. SYDOW (2) also remarks that the uredosori are very scarce in Europe, as the uredospores are soon replaced by the teleutospors, converting them into teleutosori.

The teleutospores of this species resemble somewhat those of *Puccinia Phragmitis*, but they are generally shorter in length and broader in width than those of the latter. These two species can readily be distinguished from each other by their uredospores. The uredospores of *Puccinia Moliniae*

have thicker walls (6–8 μ) and smaller size (20–28 × 20–24 μ). This species is a new addition to our fungus-flora.

37. **Puccinia oahuensis** Ell. et Ev., Bull. Torr. Bot. Club., **22,** 1895, (425); Sacc., Syll., **14,** 1899, (357); Sydow, Monogr. Ured., **1,** 1904, (771); Dietel, Ann. Mycol., **5,** 1907, (73).

Hab. On *Panicum sanguinale* L.

Shikoku.—Prov. Tosa: Akimachi (II. Oct. 1905. T. Yoshinaga); Ushioemura (II. Oct. 1906. T. Yoshinaga).

Distrib. Japan and Hawaiian Islands.

Remarks. The present species was first found parasitic on *Panicum prurientis* on Oahu Island in Hawaii.

Mr. T. Yoshinaga kindly sent to me the specimens of the present species on *Panicum sanguinale*. The Japanese plant shows a great similarity to that of Oahu, and, in fact, no points of difference between them are to be seen as was identified by Dietel (10). The teleutosori, it is said, were not found in the Oahu specimen. This is true also of our plant. The teleutospores are found mixed in the uredosori.

38. **Puccinia Phlei-pratensis** Eriks. et Henn., in Zeits. f. Pflanzenk., **4,** 1894, (140); Getreideroste, 1896, (130); Sacc., Syll., **11,** 1895, (204); Sydow, Monogr. Ured., **1,** 1904, (784); Fischer, Ured. Schw., 1904, (260).

Hab. On *Phleum pratense* L.

Hokkaidō.—Prov. Ishikari: Sapporo (II. Oct. 23, 1906. K. Miura).

Distrib. Europe and Japan.

Remarks. This species was at first included in *Puccinia graminis*, as there are apparently no distinct morphological differences between them. Eriksson and Henning (2) proved that this species has no relation to the Æcidium on *Berberis* and that the uredospores have the hibernating power. From these physiological differences, these authors are led to consider them as distinct species. In 1907, Pole Evans (1) proved the existence of the decided morphological differences between them by his cytological investigations of their uredo mycelia.

39. **Puccinia Magnusiana** Koern., in Hedw., **15,** 1876, (179); Winter,

Pilze, 1884, (221); Sacc., Syll., **7**, 1888, (631); Plowr., Brit. Ured. and Ustil., 1889, (177); Schroeter, Pilz Schles., 1889, (332); Klebahn, in Zeits. f. Pflanzenk., **2**, 1892, (337); Wirtswechs. Rostpilze, 1904, (285); Sydow, Monogr. Ured., **1**, 1904, (785); Fischer, Ured. Schw., 1904, (241); Dietel, in Engl., Bot. Jahrb., **37**, 1906, (100); McAlpine, Rusts of Australia, 1906, (125).

Hob. On *Phragmites communis* Trin.

Saghalien.—Dalni (III. Sept. 29, 1906. T. Miyake).

Hokkaidō.—Prov. Ishikari: Sapporo (III. Oct. 1889. K. Miyabe; III. Sept. 9, 1894. N. Hiratsuka; III. Oct. 20, 1895. Y. Tokubuchi; III. Oct. 4, 1896. K. Miyabe; III. Oct. 1896. J. Hanzawa; III. Oct. 10, 1899; III. Oct. 13, 1905. K. Miyabe; III. Nov. 4, 1907. M. Kasai; II. Oct. 1, 1907; III. Oct. 4, 1907; III. Sept. 29, 1907. S. Itō; III. March 4, 1908. H. Takeda); Maruyama (III. Sept. 24, 1907. S. Itō); Iwamizawa (III. Oct. 10, 1907. S. Itō); Shiroishi (II. & III. Aug. 8, 1891; III, Oct. 13, 1895. N. Hiratsuka; III. Sept. 22, 1907. M. Kasai; III. Oct. 6, 1907. S. Itō); Garugawa (II. & III. Sept. 22, 1907. S. Itō); Nagayama (III. Oct. 7, 1907. S. Itō); Tsuishikari (III. Sept. 21, 1902. G. Yamada); Ebetsu (III. Sept. 29, 1907. S. Itō); Chikabumi (III. Dec. 25, 1904. T. Miyake).—Prov. Iburi: Rebunge (III. Aug. 18, 1897. T. Nishida); Chitose (III. Oct. 13, 1900. G. Yamada); Izari (II. & III. Sept. 20, 1905. K. Miura).

Honshū.—Prov. Ugo: Sakata (II. Aug. 2, 1901. G. Yamada).—Prov. Musashi: Tokyo (III. Jan. 3, 1900. T. Nishida; III. Dec. 10, 1901; II. & III. Oct. 20, 1902. K. Yoshino; III. Sept. 11, 1905. T. Karashima).—Prov. Echigo: Yahagi (II. July 22, 1908. S. Itō); Tsubame (II. July 26, 1908. S. Itō); Yahiko (II. July 28, 1908. S. Itō).

Shikoku.—Prov. Tosa: Azono (III. Oct. 1906. T. Yoshinaga); Ushio (III. Oct. 1906. T. Yoshinaga).

Kiushū.—Prov. Higo: Ōe-mura (III. Dec. 1905. K. Yoshino); Mt. Aso & Kuchinoki (II. Nov. 23, 1905. K. Yoshino); Tamukai-mura (III. Dec. 12, 1905. K. Nakano).—Prov. Hizen: Saga (III. Nov. 1906. Y. Horikawa).—Prov. Chikuzen: Yanagawa (III. Sept. 18, 1906. K. Yoshino).

On *Ranunculus repens* L.

Saghalien.—Kshunnai (I. July 7, 1906. T. Miyake); Korsakoff (I. July 11 & 12, 1906. K. Miyabe & T. Miyagi); Chipisani (I. July 16, 1906. K. Miyabe, T. Miyake & T. Miyagi); Dalni (I. July 29, 1906. T. Miyake).

Hokkaidō.—Prov. Ishikari: Sapporo (I. June 1890. K. Miyabe; I. June 16, 1891; I. June 28, 1891. Y. Tokubuchi); Barato (I. June 18, 1893. K. Miyabe); Horomui (I. June 13, 1897. G. Yamada).

Honshū.—Prov. Musashi: Tokyo (I. 1883. K. Miyabe).

Distrib. Europe, Japan and Africa.

Remarks. This species was at first proved by Cornu (1) to have a connection with the Æcidium on *Ranunculus repens*. Plowright, Ed. Fischer and Klebahn affirmed his statement.

The present species is often found mixed with *Puccinia Phragmitis* on the same leaves of *Phragmites communis*. Macroscopically the sorus of this species is considerably smaller and less pulvinate than that of *Puccinia Phragmitis*.

The Æcidium on *Ranunculus repens* is very commonly found in our country, and they agree exactly to the description made by FISCHER (1) on the European plants. Although there is no record in Europe concerning the presence of the spermogonia, in our species they are found on the upper surface of the leaf.

40. Puccinia moriokaensis S. Itō. n. sp. (Pl. XII. Fig. 1).

Teleutosori, amphigenous, mostly hypophyllous; medium sized, oblong or sublinear, scattered or gregarious, often confluent (2.5 mm in length), naked, with torn epidermis, pulvinate, compact, thick, prominent, black. Teleutospores, fusiform or oblong-clavate, apex apiculate, rarely truncate or rounded, thickened (6-12 μ), base attenuated, not or slightly constricted at the septum, smooth, chestnut-brown, darker colored at apex, 44-70 × 12-18 μ; pedicels persistent, slender, very long, 80-100 μ, often 120 μ in length, hyaline or light yellowish brown.

Hab. On *Phragmites communis* Trin.

Honshū.—Prov. Rikuchī: Morioka (III. Oct. 29, 1905. G. YAMADA & K. SAWADA).

Distrib. Japan.

REMARKS. This species is found growing together with *Puccinia Magnusiana* on the same leaf of *Phragmites communis*. Its sorus is comparatively larger than that of the latter species; so that, macroscopically, it resembles rather that of *Puccinia Phragmitis*. Microscopically, however, the present species differs distinctly from *Puccinia Phragmitis* and approaches rather to *Puccinia Magnusiana*.

When comparing this species with other species of Puccinia on *Phragmites*, I was unable to find any species that would coincide exactly with it. From *Puccinia Phragmitis* (Schm.) Koern., *P. Trailii* Plowr., *P. obtusata* (Otth.) Ed. Fischer, *P. Isiaceæ* (Thüm.) Wint., *P. Tepperi* Ludw., *P. torosa* Thüm., and *P. Trabutii* Roem et Sacc., our species is easily distinguished by its slender teleutospore and from *Puccinia Magnusiana* Koern., *P. simi-*

lima Arth., and *P. invenusta* Syd., by its longer pedicel and slender spore. Consequently, I am inclined to regard it as a new species.

41. Puccinia Phragmitis (Schm) Koern., in Hedw., **15,** 1876, (179); Winter, Pilze, 1884, (179); Sacc., Syll., **7,** 1888, (630); Plorwr., Brit. Ured. & Ustil., 1889, (175); Schroeter, Pilz Schles., 1889, (331); Kleb., in Zeits. f. Pflanzenk., **2,** 1892, (337); **8,** 1898, (26); Wirtswechs. Rostpilze, 1904, (283); Mayus, Centralb. f. Bact. &c. II., **10,** 1903, (711); Henn., Engl. bot. Jahrb., **29,** 1901, (147); **31,** 1902, (732); **34,** 1905, (596); Sydow, Monogr. Ured., **1,** 1904, (787); Fischer, Ured. Schw., 1904, (250); Dietel, Ann. Mycol., **5.** 1907, (73).

Hab. On *Phragmites communis* Trin.

Saghalien.—Kshunnai (II. & III. Aug. 10, 1906. K. Miyabe & T. Miyagi); Ushoro (II. & III. Aug. 11, 1906. K. Miyabe & T. Miyagi).

Hokkaidō.—Prov. Ishikari: Sapporo (II. & III. Aug. 4, 1889. K. Kodera; III. Aug. 1895. Y. Tokubuchi; III. Oct. 10, 1895; III. Oct. 4, 1896. K. Miyabe; III. Oct. 13, 1905. N. Hiratsuka & J. Hanzawa; II. July 20, 1907; III. Sept. 10, 1907; III. Oct. 13, 1907; III. Dec. 1907. S. Itō; II. Sept. 2, 1907, M. Kasai); Chikabumi (III. Dec. 25, 1904. T. Miyake); Garugawa (III. Sept. 22, 1907. S. Itō); Ebetsu (III. Sept. 29, 1907. S. Itō); Shiroishi (III. Oct. 6, 1907. S. Itō); Takikawa (III. Oct. 8, 1907. M. Kasai).—Prov. Iburi: Usu (III. Aug. 15, 1890. K. Miyabe).—Prov. Oshima: Zenikamezawa (III. Nov. 12, 1900. T. Kawakami).—Prov. Kitami: Rishiri-Island (III. Aug. 20, 1907. M. Miura).

Honshū.—Prov. Rikuchū: Mt. Nanshō (III. Sept. 30, 1906. G. Yamada).—Prov. Ugo: Osaruzawa (III. Nov. 1902. Y. Tokubuchi).—Prov. Shimotsuke: Akanumagahara (II. & III. Aug. 11, 1891. S. Hori); Yumoto (III. Aug. 29, 1904. S. Kusano).—Prov. Musashi: Ogikubo (III. Sept. 3. 1899. S. Kusano; III. Nov. 5, 1899. M. Shirai); Shimura (III. Oct. 27, 1905. N. Nambu).—Prov. Echigo: Suita (III. Aug. 20, 1908. S. Itō).

Kiushū.—Prov. Higo: Oe-mura (III. Aug. 1, 1906. K. Yoshino).

On *Rumex domesticus* Hartm.

Saghalien.—Chipisani (I. July 16, 1906. K. Miyabe, T. Miyake & T. Miyagi).

Hokkaidō.—Prov. Ishikari: Sapporo (I. June 18, 1890. Y. Tokubuchi; I. June 20, 1891; I. June 1897. K. Miyabe; I. June 15, 1907. S. Itō); Shinkotoni (I. June 3, 1900. G. Yamada).

Honshū.—Prov. Musashi: Akabane (I. April 1900. S. Kusano); Shimura (I. May 1, 1901. K. Miyabe).—Prov. Echigo: Nagaoka (I. June 3, 1906. M. Nakamura).

Distrib. Asia, Africa, Europe, America and Australia.

Remarks. Winter (1) was the first to study the life-history of the Puccinia on *Phragmites communis*. Stahl, Schroeter and Rostrup

have also studied about it. This species has been a subject of considerable confusion, as it is often found mixed together with *Puccinia Magnusiana*. PLOWRIGHT, after many infection experiments during 1882–1885, proved the relation of this Puccinia to the Æcidium on *Rumex hydropathum* Huds., *R. conglomeratum* Murr., *R. obtusifolium* L., *R. crispus* L., and *Rheum officinale* Bail. And he also proved on the other hand, that the Æcidium on *Rumex acetosa* or *Ranunculus sps.* have no relation at all to this species.

Puccinia Trailii Plowr. (Æcidium on *Rumex acetosa*) differs from the present species only in biological characters, the teleutospores of both species being exactly the same in general morphological character.

I successed in infecting *Rumex domesticus* by the basidiospores of the present species.

42. **Puccinia okatamaensis** S. Itō. n. sp.—(Pl. XII. Fig. 2.)

Teleutosori, on the sheath and culm; medium or large sized, oblong or linear, often confluent, gregarious, sometimes 1.5 cm in length, naked, with torn epidermis, compact, thick, prominent, somewhat pulvinate or immersed in the tissue, black. Teleutospores, oblong or long fusiform, apex thickened (7—10 μ), apiculate or rarely rounded, base attenuated, more or less constricted at the septum, smooth, cinnamon-colored, 50—78 × 11—20 μ; epispore rather thick; pedicels light yellowish brown, conspicuous at the upper portion, thick, persistent, 94 μ in length.

Hab. On *Phragmites communis* Trin.

Hokkaidō.—Prov. Ishikari: Okatama (III. March 21, 1891. K. MIYABE); Ebetsu (III. April 25, 1908. S. SUWA).

Honshū.—Prov. Echigo: Okawazu (III. April 13, 1903. K. YOSHINO).—Prov. Musashi: Todahara (III. Nov. 5, 1899. T. NISHIDA).—Prov. Mino: Gifu (III. March 24, 1893. S. HORI).

Distrib. Japan.

REMARKS. The species always forms long, conspicuous, confluent sori on the sheath and culm, but not on the blade. Sometimes the sori of *Puccinia Magnusiana* are found together on the leaf blade of the same plant.

The cases of the sorus immersed in the tissue and forming a long line are not found in other related species. *Puccinia Phragmitis* forms also an elongated teleutosorus on the sheath but is not so gregarious and narrow as the present species. While comparing our plant with other species of Puc-

cinia on *Phragmites communis*, I was able to find the following differences. By its longer pedicel and larger spores, our species is distinguished from *Puccinia Magnusiana* and *P. simillima*. And from other species, our plant is easily distinguished by its narrower and cinnamon-colored spores. The basidiospores of this species have no power to infect *Rumex domesticus*.

43. Puccinia aestivalis Diet., in Engl., Bot. Jahrb., **34**, 1905, (585); **37**, 1906, (101).—(Pl. XII. Fig. 3).

Hab. On *Pollinia nuda* Trin.

Honshū.—Prov. Musashi: Tokyo (II. July 1901. G. YAMADA; III. Sept. 22, 1905. N. NAMBU). —Prov. Uzen: Ōmagari (II. & III. July 31, 1908. M. MIURA).

Distrib. Japan.

REMARKS. DIETEL (8) writes that the teleutospores germinate at once when ripe. I also recognized the same fact in our specimens. According to him its teleutospores are somewhat like those of *Puccinia Pollinia* Barcl., of Himalaya in general characters.

According to DIETEL (9), this fungus has two kinds of uredospores; one is globose or oval in shape, echinulate, with a light brownish-colored thin epispore, while the other is piriform or oval in shape, nearly smooth, and deep brown in color.

From the statement of DIETEL it seems that these two kinds of uredospores occur in separate sori; but during the course of my study, I found that both of them are formed in the same sorus.

44. Puccinia microspora Diet., in Engl., Bot. Jahrb., **37**, 1906, (101).—(Pl. XII. Fig. 4).

Hab. On *Rottbœllia compressa* L. var. *japonica* Hack.

Honshū.—Prov. Musashi: Tokyo (II. & III. Oct. 12, 1904. N. NAMBU).

Distrib. Japan.

REMARKS. I was able to examine the type specimen of this species by the kindness of Mr. N. NAMBU. The present species differs entirely, as DIETEL (9) remarked, from *Uredo Rottbœlliæ* and *Puccinia Rottbœlliæ*. Compared with *Uredo Rottbœlliæ*, the uredosori of our species are smaller in size, and are generally loosely covered by the epidermis, and also its urdospores are smaller with capitate paraphyses intermixed with them.

Compared with *Puccinia Rottbœlliæ*, our species has smaller teleutospores and subdeciduous, colored, short pedicels.

45. Puccinia Miyoshiana Diet., in Engl., Bot. Jahrb., **27,** 1900, (569); **28,** 1901, (283); Sacc., Syll., **16,** 1902, (311); Syd., Monogr. Ured., **1,** 1904, (809).

Syn.: *Uredo Miscanthi* P. Henn. in Schedule.

Hab. On *Spodiopogon cotulifer* Hack.

Hokkaidō.—Prov. Iburi: Chitose (II. Sept. 2, 1896. K. MIYABE).

Honshū.—Prov. Musashi: Tokyo (II. & III. Sept. 22, 1899. S. KUSANO, II. & III. Aug. 1. 1904. N. NAMBU).—Prov. Awa: Fura (II. July 29, 1893. K. MIYABE).—Prov. Echigo: Tohō (II. & III. Aug. 12, 1908. S. ITŌ).

Shikoku.—Prov. Tosa: Kamo-mura (II. June 1901. T. YOSHINAGA); Anamae-mura (II. Oct 1904. T. YOSHINAGA).

Kiushū.—Prov. Hizen: Saga (II. Sept. 16, 1907. K. YOSHINO).

On *Spodiopogon sibiricus* Trin.

Honshū.—Prov. Musashi: Tokyo (III. Oct. 1903; II. Aug. 15, 1904. S. KUSANO; III. Sept. 1904. M. SHIRAI).

Kiushū.—Prov. Higo: Mt. Aso (II. Aug. 1901. T. KAWAKAMI).

Distrib. Japan and Siberia.

REMARKS. DIETEL (3) described this species from the specimens collected at the Tokyo Botanic Garden in 1898 by Prof. MIYOSHI, and he fully discussed its distinctive features from *Puccinia Eulaliæ*, *P. Polliniæ* and *P. subnitens*.

Uredo Miscanthi P. Henn. ought to be referred to here. P. HENNIGS gave, although it has not yet been published, the above name to a Uredo on *Spodiopogon cotulifer* Hack. (=*Miscanthus cotulifer*) which was sent him by Mr. T. YOSHINAGA. On examining the original specimen of *Uredo Miscanthi*, I came to the conclusion that it is nothing but the uredostage of our *Puccinia Miyoshiana*.

46. Puccinia Stipæ-sibiricæ S. Itō. n. sp.—(Pl. XII. Fig. 5).

Teleutosori, amphigenous, mostly epiphyllous; small, oblong or roundish, densely scattered over the surface, arranged in lines, sometimes confluent, naked, with torn epidermis, pulvinate, conspicuous, brownish black. Uredospores are frequently mixed in the sori.

Uredospores, ellipsoidal to globose, densely echinulate, 16–22 × 15–18 μ; epispore thick (about 2 μ), yellowish or brownish-colored; germ-pores 4, scattered.

Teleutospores, clavate or oblong-clavate, apex acutely conical or rounded, thickened (6–12 μ), rarely not thickened, slightly or markedly constricted at the septum, chestnut-brown, somewhat lighter colored at apex, 30–58 × 16–22 μ; pedicels hyaline or subhyaline, as long as the spores or 80 μ in length, persistent. Mesospores occasionally mixed in the sori.

Hab. On *Stipa sibirica* Lam.

Hokkaidō.—Prov. Ishikari: Sapporo (III. Oct. 4, 1894; III. Sept. 1895. K. MIYABE; III. Oct. 1, 1896. Y. TOKUBUCHI).—Prov. Iburi: Chitose (III. Oct. 10, 1900. G. YAMADA).

Distrib. Japan.

REMARKS. There are many species of Puccinia already known to be parasitic on *Stipa*. They are:—*Puccinia graminella* (Speg.) Diet. et Holw., *P. graminella* var. *chilensis* Neger., *P. graminella* var. *Neesiana* Speg., *P. Stipæ* (Opiz.) Arth., *P. flavescens* McAlp., *P. Burnetti* Griff., *P. substerilis* Ell. et Ev., and *P. wolgensis* Nawasch. Among them there are no species which are known to infect *Stipa sibirica*. The uredospores of this species is very small in size. *Puccinia Stipæ* approaches it in the point of smallness of the uredospore. But they differ from each other in the position of the teleutosori, and in the length of the teleutospore and its pedicel. The length of teleutospore in ours is longer, while that of pedicel is considerably shorter. From other species, the present fungus differs so evidently that there is no need of stating the differences between them.

47. Puccinia Zoysiæ Diet., in Engl., Bot. Jahrb., **32**, 1903, (48); Sydow, Monogr. Ured., **1**, 1904, (833); Sacc., Syll., **17**, 1905, (375).

Syn.: *Uredo Zoysiæ* P. Henn. in Schedule.

Hab. On *Zoysia pungens* Willd. var. *japonica* Hack.

Honshū.—Prov. Rikuchū: Inzan-mura (III. June 29, 1897. Y. TAKAHASHI); Morioka (II. & III. Sept. 23, 1905; III. Nov. 1907. G. YAMADA; II. July 28, 1907. M. MIURA).—Prov. Mutsu: Komaki (III. Oct. 4, 1895. K. SENGOKU).—Prov. Musashi: Tokyo (III. Nov. 7, 1899; II. & III. Aug. 12, 1904. S. KUSANO).—Prov. Echigo: Mt. Sugana (III. July 11, 1906. T. KURIHARA).—Prov. Ōmi: Naimura (III. April 11, 1899. T. NISHIDA).

Shikoku.—Prov. Tosa: Kōchi (II. June 1901; III. Dec. 1907. T. YOSHINAGA).

Kiushū.—Prov. Higo: Imizu-mura (II. July 4, 1905. K. YOSHINO).

Distrib. Japan.

REMARKS. This is the only species of Puccinia on *Zoysia* hitherto known. DIETEL (6) states that his description of the uredospore is not complete being unable to get a good specimen. I shall note my own observation on the uredostage of this fungus in the following paragraph.

Uredosori, mostly epiphyllous; minute, oblong or linear, gregarious, often confluent, naked, with ruptured epidermis, pulverulent, light orange-colored. Uredospores, oblong, obovate or broadly ellipsoidal, verrucoso-echinulate, light yellow or hyaline, 18–22 × 15–17 μ; germ-pores 2, inconspicuous; epispore thick, especially at the apex; paraphyses absent in the sori.

Previous to DIETEL'S description, a specimen of the same species, collected by Mr. T. YOSHINAGA in 1901, was sent to P. HENNINGS. The author named it *Uredo Zoysiæ* P. Henn., although its description seems never to have been published. Examining the original specimen of *Uredo Zoysiæ* P. Henn., I see no points of difference from our present species.

Puccinia on Bambuseæ.

48. Puccinia Phyllostachydis Kusano, in Bull. Coll. Agric. Tokyo Imp. Univ., **8**, 1908, (2).

Hab. On *Phyllostachys bambusoides* S. et Z.

Honshū.—Prov. Musashi: Tokyo (II. & III. March 2, 1903; II. & III. March 5, 1903. S. KUSANO).—Prov. Yamashiro: Kyoto (II. June 12, 1895. N. HIRATSUKA; II. July 14, 1895. T. TAKAHASHI).

On *Phyllostachys bambusoides* S. et Z. var. *aurea* Makino.

Honshū.—Prov. Musashi: Tokyo (II. & III. March 5, 1903; II. & III. March 20, 1903. S. KUSANO; II. Aug. 1893. K. MIYABE).

On *Phyllostachys bambusoides* S. et Z. forma *Kashirodake* Makino.

Honshū.—Prov. Musashi: Tokyo (II. & III. March 27, 1903. S. KUSANO).

Distrib. Japan.

REMARKS. The macroscopical appearance of this species agrees with that of other Puccinia on Bambuseæ. But its paraphyses are very characteristic being often septate and thick walled. The teleutospores which are not so much thickened at apex, can be distinguished from those of *Puccinia Kusanoi* and *P. xanthosperma*. The length of pedicel of this fungus is

longer than that of *P. melanocephala* Syd. (about ten times), although it approaches in the slight thickening on its apex. Moreover, the presence of the paraphyses distinguishes this species from *Puccinia Arundinariæ*.

Prof. KUSANO (3) described this species in 1908 and he remarked that it is confined to four forms of *Phyllostachys bambusoides*: namely *Phyllostachys bambusoides* and var. *aurea*, *Marliacea*, and forma *Kashiredake*, but not to any other species of this genus.

49. Puccinia Kusanoi Diet., in Engl., Bot. Jahrb., **27**, 1900, (568); P. Henn., in Engl., Bot. Jahrb., **28**, 1901, (261); **31**, 1902, (731); Sacc., Syll., **16**, 1902, (309); Sydow, Monogr. Ured., **1**, 1904, (732); Kusano, Bull. Coll. Agric. Tokyo Imp. Univ., **8**, 1908, (5).

Syn.: *Uredo Arundinariæ* Syd., in Hedw., **37**, 1898, ([208]); Sacc., Syll., **14**, 1892, (406).

Hab. On *Arundinaria Simoni* Riv.

Honshū.—Prov. Mutsu: Goshogawara (II. Nov. 1904. T. KASHIWAI).—Prov. Ugo: Akita (II. & III. Nov. 1903. Y. TOKUBUCHI).—Prov. Iwashiro: Mt. Shinobu (II. & III. June 15, 1903. T. MIYAKE).—Prov. Shimōsa: Chiba (III. Jan. 1, 1896. K. SENGOKU).—Prov. Musashi: Tokyo (III. April 30, 1883. K. ŌMURA; II. Sept. 1889. K. MIYABE; II. & III. March 19, 1891; II. Oct. 15, 1891. S. HORI; II. & III. Nov. 25, 1895; III. Jan. 14, 1896. K. SENGOKU; III. April 24, 1900. T. NISHIDA); Ōmiya (III. Oct. 1886. Y. ICHIKAWA).—Prov. Sagami: Hakone (III. April 1891. S. HORI; II. & III. April 12, 1901. K. MIYABE).—Prov. Mino: Mt. Kinkwa (II. & III. Dec. 3, 1898; Y. TOKUBUCHI); Gifu (II. & III. Oct. 1889. Y. TOKUBUCHI).—Prov. Settsu: Osaka (II. & III. 1903. A. IDETA).—Prov. Tsushima: Izuhara (II. Aug. 1901. K. YABE).

On *Arundinaria Simoni* Riv. var. *Chino* Mak.

Honshū.—Prov. Ugo: Akita (II. & III. 1896. T. YOSHINO).—Prov. Musashi: Tokyo (II. & III. June 5, 1899. S. KUSANO; II. July 21, 1899. Y. TOKUBUCHI; II. Aug. 11, 1900. G. YAMADA; III. Feb. 2, 1902. K. YOSHINO; II. & III. March 26, 1902. N. NAMBU).—Prov. Rikuchū: Sendai (II. Oct. 5, 1895. K. SENGOKU).—Prov. Izu (III. May 1898. M. SHIRAI).—Prov. Sagami: Odawara (III. Jan. 13, 1898. K. MIYABE).

Kiushū.—Prov. Higo: Mt. Kinkwa (III. June 14, 1906. K. YOSHINO).

On *Aruddinaria Simoni* Riv. var. *variegata* Hack.

Kiushū.—Prov. Higo: Ōe-mura (II. Oct. 3, 1905. K. YOSHINO).

On *Arundinaria Narihira* Mak.

Honshū.—Prov. Musashi: Tokyo (III. May 5, 1903. S. KUSANO).

On *Arundinaria Narihira* Mak. forma *Yashadake* Mak.

Honshū.—Prov. Musashi: Tokyo (III. May 3, 1903. S. KUSANO).

On *Arundinaria variabilis* Mak. var. *viridi-striata* Mak.

Honshū.—Prov. Musashi: Tokyo (II. 1897. M. Miyoshi).

Shikoku.—Prov. Tosa: Sakawa (II. May 1900. T. Yoshinaga).

On *Arundinaria variabilis* Mak. forma *foliis glabris* Mak.

Honshū.—Prov. Musashi: Tokyo (II. July 21, 1895. Y. Takahashi).

On *Arundinaria variabilis* Mak, forma *foliis pubescentibus* Mak.

Honshū.—Prov. Mutsu: Hirosaki (II. & III. Oct. 26, 1896. N. Hiratsuka).—Prov. Iwaki: Shiraishi (II. Aug. 1, 1895. Y. Takahashi).—Prov. Owari: Nagoya (II. June 19, 1895. Y. Takahashi)

On *Sasa nipponica* Mak. et Shib.

Honshū.—Prov. Mutsu: Hirosaki (III. April 1897. N. Hiratsuka); Asagishi-mura (III. Nov. 7, 1897. Y. Takahashi).—Prov. Rikuchū: Sannozan (III. May 13, 1893. Y. Takahashi); Morioka (II. & III. May 17, 1903; II. & III. March 13, 1904. G. Yamada; II. Sept. 23, 1904. K. Sawada).

Distrib. Japan.

Remarks. In 1898, Sydow (1) described the uredostage of this fungus by the specimen of *Arundinaria Fortunei* var. *aurea* under the name of *Uredo Arundinariæ*. In 1900, Dietel (3) gave the present name, describing the teleutostage on *Arundinaria Fortunei* and *A. Simoni*.

This species differs from *Puccinia longicornis* in the absence of paraphyses in the uredosori and also in the shape of the apex of teleutospores. In regard to the latter character, however, the transitional forms are occasionally found between *Puccinia Kusanoi* and *P. longicornis*. I found among the teleutospores of the present species some having even an apex 18μ thick; while on the other hand, among *Puccinia longicornis* there are some only 8μ thick at the apex.

The present species is more common in Japan than the other species of Puccinia growing on Bambuseæ and the number of its host-plants are also more numerous.

50. Puccinia Kusanoi Diet. var. **Azuma** Kusano., in Bull. Coll. Agric. Tokyo Imp. Univ., **8,** 1908, (8).

Hab. On *Sasa ramosa* Mak. et Shib.

Honshū.—Prov. Iwaki: Sōma (II. & III. April 1903. S. Kusano).

Distrib. Japan.

Remarks. Prof. Kusano (3) described this variety of *Puccinia Kusanoi*, distinguishing it from the typical form by the longer teleutospores and by the presence of less constriction at septum. With the exception of the shape

of the thickened apex, the general form of the spore approaches rather near to *Puccinia longicornis* than to *Puccinia Kusanoi*, as has already remarked by Prof. KUSANO.

I have also found mixed in one and same sorus of the variety some teleutospores closely resembling the typical spores of *Puccinia Kusanoi*.

51. Puccinia longicornis Pat. et Har., in Bull. Soc. Myc. France, **7**, 1891, (143); Sacc., Syll., **11**, 1895, (200); Dietel, in Engl., Bot. Jaharb., **27**, 1900, (568); **37**, 1906, (102); Sydow, Monogr. Ured., **1**, 1904, (734); Kusano, Bull. Coll. Agric. Tokyo Imp. Univ., **8**, 1908, (4).

Hab. On *sasa paniculata* Mak. et. Shib.

Hokkaidō.—Prov. Ishikari: Mt. Sankaku (III. May 4, 1902. T. MIYAKE); Sapporo (III. May 5, 1908. M. KASAI; III. May 7, 1908; III. May 18, 1909. S. ITŌ).—Prov. Shiribeshi: Yoichi (II. & III. May 14, 1908. M. KASAI).

Honshū.—Prov. Mutsu: Hirosaki (II. & III. July 18, 1896. K. KIKUCHI); Goshogawara (II. Sept. 1904. T. KASHIWAI); Hachinohe (III. April 28, 1905. G. YAMADA).—Prov. Echigo: Fukudomura (III. April 13, 1903. K. YOSHINO).—Prov. Musashi: Tokyo (II. Oct. 15, 1891. S. HORI; III. Feb. 27, 1897. M. SHIRAI; III. Nov. 25, 1898. S. KUSANO; III. 1899. M. MIYOSHI; III. March 26, 1900. T. NISHIDA; III. March 15, 1903; III. April 1907. S. KUSANO).

Kiushū.—Prov. Higo: Kumamoto (II. & III. March 12, 1905. K. YOSHINO); Kiuhonji (III. March 12, 1905. K. YOSHINO); Kurokawa (II. Aug. 13, 1906).

On *Sasa albo-marginata* Mak. et Shib,

Kiushū.—Prov. Higo: Mt. Aso (III. April 3, 1907. T. TADA).

On *Arundinaria japonica* S. et Z.

Honshū.—Prov. Musashi: Tokyo (II. & III. June 14, 1899. S. KUSANO).—Prov. Owari: Nagoya (II. July 1895. Y. TAKAHASHI).

Distrib. Japan.

REMARKS. This species is readily distinguished from *Puccinia Kusanoi*, *P. Sasæ* and *P. Phyllostachyäis* by the cylindrically elongated apex of its teleutospore (13–32μ sometimes 38μ in length), and the presence numerous clavate paraphyses in the uredosori. By DIETEL (9), this species is recorded as parastic on *Phyllostachys bambusoides* S. et Z. (=*P. Quilici* Riv.), collected by Mr. YOSHINAGA in Shikoku. From my own observation, the fungus does not attack any species of *Phyllostachys*.

52. Puccinia mitriformis S. Itō. n. sp.—(Pl. XII. Fig. 6).

Teleutosori, hypophyllous; large, roundish, scattered or subgregarious,

not confluent, naked, pulvinate, prominent, compact, thick, sooty-black or brownish-black. Teleutospores, oblong-clavate or fusiform, apex extraordinarily conically elongatæd (36–84μ, sometimes 90μ in length), subacute, base somewhat attenuated, not or slightly constricted at the septum, smooth, light yellowish-orange or whitish-yellow, hyaline or lighter colored at the tip of apex, 80–130 × 18–23μ; pedicels hyaline, fine, extraordinarily long, (100–240μ, sometimes 280μ), slender, subdeciduous. Mesospores are frequently mixed in the sori.

Hab. On *Sasa paniculata* Mak. et Shib.

Honshū.—Prov. Rikuchū: Dainoyu (III. April 25, 1907. G. YAMADA).

Distrib. Japan.

REMARKS. The species of Puccinia hitherto known to be parasitic on the Japanese Bambuseæ are *Puccinia Kusanoi*, *P. Phyllostachydis*, *P. longicornis* and *P. Sasæ*. A fifth species is here added, based on the specimen obtained from Prof. G. YAMADA. It grows on *Sasa paniculata*. At first sight it is quite indistinguishable from *Puccinia longicornis* macroscopically. It is only when examined under a microscope, that these two species are distinguishable from each other. The apex of the teleutospore of the present species is conically elongated reaching nearly 90μ in length, while that of *Puccinia longicornis* is cylindrically elongated attaining about 38μ in its maximum length. Moreover, the teleutospores of the former species are slightly constricted at the septum, with extremely long slender subdeciduous pedicels, and also with many mesospores intermixed. I regard this fungus for the above mentioned reasons as a new species. The uredostage of this fungus is not yet obtained.

53. Puccinia Sasæ Kusano, Bull. Coll. Agric. Tokyo Imp. Univ., **8**, 1908, (9).

Hab. On *Sasa borealis* Mak. et Shib.

Distrib. Japan.

REMARKS. This species was described by Prof. KUSANO from the specimen collected at Nikko by Mr. T. MAKINO. This species is said to resemble *Puccinia Phyllostachydis* in general appearance, but it differs in the upper cell being wider and shorter than the lower, and also in its para-

physes being not septated. Moreover, the uredospore of the present species is the largest in the species of Puccinia growing on Bambuseæ.

Uredostage only, found in Japan.

54. Puccinia Agrostidis Plowr., in Bot. Chron., **8**, 1890, (139); Sacc., Syll., **11**, 1895, (202); Sydow, Monogr. Ured., **1**, 1904, (717); Fischer, Ured. Schw., 1904, (353); McAlpine, Rusts of Australia, 1906, (114).

Hab. On *Agrostis perennans* Tuck.

Hokkaidō.—Prov. Ishikari: Ebetsu (II. Sept. 29, 1907. S. Itō).

Distrib. Europe, Japan, Siberia, India and Australia.

REMARKS. Our specimen has only the uredostage. A hyaline epispore as well as general shape and size of the spore point to its identity with *Puccinia Agrostidis*. But as there are no records about the number of germ-pores of *Puccinia Agrostidis*, the exact identification is somewhat difficult. In ours there are 4–6 germ-pores.

This fungus forms its Æcidium on the species of *Aquilegia* in Europe; but in our country, Æcidium on *Aquilegia* is not yet found.

55. Puccinia Baryi (Berk. et Br.) Wint., Pilze, 1884, (178); Sacc., Syll., **7**, 1888, (660); Plowr., Brit. Ured. & Ustil., 1889, (191); Schrœter, Pilz Schles., 1889, (338); P. Henn., in Engl., Bot. Jahrb., **31**, 1902, (732); **34**, 1905, (596); Sydow, Monogr. Ured., **1**, 1904, (737); Fischer, Ured. Schw., 1904, (369).

Hab. On *Brachypodium silvaticum* Beauv.

Hokkaidō.—Prov. Ishikari: Shiroishi (II. Oct. 6, 1907. S. Itō).—Prov. Iburi: Mororan (II. Aug. 3, 1900. G. YAMADA).—Prov. Kitami: Rishiri-Island (II. Sept. 1, 1899. T. KAWAKAMI).

Honshū.—Prov. Musashi: Takaoyama (II. July 25, 1901. N. NAMBU).

Distrib. Europe, Japan and India.

REMARKS. The teleutostage of this fungus has not yet been found in our country. Consequently, it is somewhat difficult to settle exactly its systematic position. However, the presence of paraphyses and the character of the uredospores coincide very closely with the description of *Puccinia Baryi*.

Brachypodium silvaticum is the only plant I have examined as a host for this fungus. P. HENNINGS recorded *Brachypodium japonicum* as its host-plant.

Æcidium stage only, found in Japan.

56. Puccinia perplexans Plowr., Quart. Journ. Micr. Sc., **25,** 1885, (164); Brit. Ured. and Ustil., 1889, (179); Sacc., Syll., **7,** 1888, (632); Dietel, in Hedw., **28,** 1889, (278); in Engl., Bot. Jahrb., **34,** 1905, (585); Klebahn, Zeits. f. Pflanzenk., **12,** 1902, (145); Sydow, Monogr. Ured., **1,** 1904, (719).

Syn.: *Æcidium Ranunculacearum* DC., Fl. franç., **6,** (97).

Hab. On *Ranunculus acer* L. var. *Steveni* Rgl.

Saghalien.—Kshunnai (I. July 7, 1906. T. MIYAKE).

On *Ranunculus acer* L. ?

Saghalien.—Ōdomari (I. June 19, 1906. T. MIYAKE); Darny (I. June 27, 1906. T. MIYAKE).

On *Ranunculus japonicus* Langs.

Hokkaidō.—Prov. Ishikari: Sapporo (I. June 15, 1890. K. MIYABE; I. June 3, 1900. G. YAMADA); Horomui (I. June 13, 1897. G. YAMADA).

Honshū.—Prov. Musashi: Shimura (I. May 1, 1901. K. MIYABE).

Distrib. Europe and Japan.

REMARKS. In Europe, the present species produces its uredo- and teleutospores on *Alopecurus pratensis*; whose genetic relation with the Æcidium on *Ranunculus acer* was experimentally proved by PLOWRIGHT in 1885.

The presence of the uredo- and teleutospores of this fungus in Japan is not yet recorded. In 1905, DIETEL identified the Æcidium on *Ranunculus acer* var. *japonicus* as the present species from the specimen sent to him by Mr. NAMBU.

The specimens preserved in the University Herbarium are on *Ranunculus acer* var. *Steveni* and var. *japonicus*. They agree exactly in their morphological characters with the European specimens of *Puccinia perplexans*. Another form of Æcidium on *Ranunculus acer* in Europe was combined experimentally by SCHROETER with *Uromyces Dactylidis*. The uredo- and teleutospores of this Uromyces are also not yet found in our

conntry. The Æcidium of *Uromyces Dactylidis* has many points of difference when compared to our Æcidium. In the former species, peridia are recurved, and the walls of the peridial cells are thicker.

57. Puccinia persistens Plowr., Brit. Ured. and Ustil., 1889, (180); Sacc., Syll., **9,** 1891, (312); Dietel, in Engl., Bot. Jahrb., **27,** 1900, (568); **28,** 1901, (283); P. Henn., in Engl., Bot. Jahrb., **31,** 1902, (732); **34,** 1905, (596); Sydow, Monogr. Ured., **1,** 1904, (825); Fischer, Ured. Schw., 1904, (347).

Syn.: *Æcidium Thalictri-flavi* Wint., Pilze, 1889, (269).

Hab. On *Thalictrum minus* L.

Sagʻhalien.—Mauka (I. July 5, 1906. T. Miyake); Mereya (I. July 14, 1906. K. Miyabe & T. Miyagi); Chirihasan (I. July 25, 1906. K. Miyabe & T. Miyagi); Tomarizawa (I. July 23, 1906. T. Miyake); Mt. Dainan, Todomoshiri (I. July 26, 1906. T. Miyake).

Hokkaidō.—Prov. Ishikari: Sapporo (I. June 30, 1890; I. June 26, 1891. K. Miyabe); Tsukisapp (I. June 25, 1893. T. Kawakami).—Prov. Hitaka: Niikapp (I. July 13, 1907. M. Kasai).—Prov. Nemuro: Pinnetkemoi prope åppid. Nemuro (I. July 5, 1909. H. Takeda).

Distrib. Europe, North America, Japan, Siberia and India.

Remarks. Æcidia on *Thalictrum* are related to *Puccinia persistens*, *P. septentorionalis* and *P. borealis*. Our Æcidium coincides in all characters to those of *Puccinia persistens*. Its teleutostage is found on *Triticum repens* and *Poa nemoralis* in Europe, but it is not yet found in our country.

58. Puccinia Festucæ Plowr., Bot. Chron., 1890, (42, 139); Klebahn, Zeits. f. Pflanzenk., **4,** 1894, (138); **5,** 1895, (150); Sacc., Syll., **11,** 1895, (194); Sydow, Monogr. Ured., **1,** 1904, (752); Fischer, Ured. Schw., 1904, (377); Dietel, in Engl., Bot. Jahrb., **37,** 1906, (102).

Syn.: *Æcidium Caprifoliacearum* DC. Fl. franç., **2,** 1815, (597).

Hab. On *Lonicera cærulea* L. var. *villosa* Torr. et Gray.

Sagʻhalien.—Chirihasan (I. July 25, 1906. K. Miyabe & T. Miyagi).

Kurile-Island.—(I. Aug. 1884. K. Miyabe).

Hokkaidō.—Prov. Kitami: Rishiri-Island (I. Aug. 1, 1899. W. Hirose & T. Kawakami).

On *Lonicera Chamissoni* Bge.

Sagʻhalien.—Dubki (I. July 22, 1906. K. Miyabe & T. Miyagi); Chirihasan (I. July 25, 1906. K. Miyabe & T. Miyagi); Higashiyama (I. Aug. 28, 1906. T. Miyake); Korsakoff (I. Aug. 4, 1906. K. Miyabe & T. Miyagi); Slikka (I. Aug. 12, 1906. T. Miyake).

On *Lonicera chrysantha* Turcz.

Saghalien.—Mereya (I. July 14, 1906. K. MIYABE, T. MIYAKE & T. MIYAGI).

On *Lonicera Glehni* Fr. Schm.

Saghalien.—Korsakoff (I. July 12, 1906. K. MIYABE & T. MIYAGI).

On *Lonicera Maximowiczii* Rupr.

Saghalien.—Dubki (I. July 22, 1906. K. MIYABE & T. MIYAGI).

Distrib. Europe, North America and Japan.

REMARKS. DIETEL (9) recorded for the first time the presence of the Æcidium stage of this species on *Lonicera emphyllocalyx* (=*L. cærulea* var. *villosa*?) which was collected by Prof. YENDO in 1903 in the Kurile-Islands. The same Æcidium was collected on *Lonicera cærulea* var. *villosa* by Prof. MIYABE in 1884 also in the Kuriles. It was also abundantly collected in Saghalien on different species of *Lonicera* by Prof. K. MIYABE, Messrs. T. MIYAKE and T. MIYAGI.

In the last summer, I found a uredo growing on *Festuca ovina* in Prov. Echigo. It resembles very closely the uredospore of *Puccinia Festucæ*.

59. Puccinia Agropyri Ell. et Ev., in Journ. of Mycol., **7,** 1892, (131); Sacc., Syll., **11,** 1895, (201); Dietel, in Engl., Bot. Jahrb., **27,** 1900, (568); **32,** 1903, (625); **37,** 1906, (102); P. Henn., in Engl., Bot. Jahrb., **31,** 1902, (731); Klebahn, Wirtswechs. Rostpilze, 1904, (292); Sydow, Monogr. Ured., **1,** 1904, (823); Fischer, Ured. Schw., 1904, (350); McAlpine, Rusts of Australia, 1906, (113).

Syn.: *Æcidium Clematidis* DC. Fl. franç., **2,** 1815, (243).

Hab. On *Clematis paniculata* Thunb.

Hokkaidō.—Prov. Oshima: Satsukari (I. July 13, 1893. K. MIYABE); Okushiri (I. July 27, 1890. K. MIYABE); Esashi (I. Aug. 10, 1900; I. Aug. 18, 1902. G. YAMADA).

Honshū.—Prov. Owari: Chita (I. May 2, 1899. Y. TOKUBUCHI).—Prov. Harima: Himeji (I. May 8, 1899. Y. TAKAHASHI).

Shikoku.—Prov. Tosa: Nōzu-mura (I. May 1901. T. YOSHINAGA).

Kiushū.—Prov. Hizen: Fukuda (I. May 8, 1896. G. KUROSAWA).

On *Clematis apiifolia* DC.

Honshū.—Prov. Rikuchū: Kuroishino (I. July 5, 1903. G. YAMADA); Takizawa (I. July 15, 1903. G. YAMADA); Morioka (I. June 20, 1897. G. YAMADA; I. July 15, 1903. S. ARIMOTO).

On *Clematis fusca* Turcz.

Hokkaidō.—Prov. Ishikari: Horomui (I. July 9, 1896. J. KASAHARA; I. July 20, 1900. G. YAMADA).

Distrib. Europe, America and Japan.

REMARKS. The teleutostage of this fungus is found on *Agropyrum glaucum*, *A. junceum* and *A. occidentalis* in Europe and America; but it is not yet collected in our country. The æcidial stage is commonly found in different places of our country.

DIETEL (3) after examining the Japanese specimens identified them as the Æcidium stage of *Puccinia Agropyri*. I have also carefully compared our Æcidium with American specimens of *Æcidium Clematidis*, and have noticed no differences between them.

DIORCHIDIUM Kalchb.

1. Diorchidium levigatum Syd. et Butl., in Ann. Mycol., **5**, 1907, (500).—(Pl. XII. Fig. 7).

Uredosori, amphigenous, mostly epiphyllous; minute, oblong or roundish, on the brownish or blackish discolored spots, scattered or gregarious, rarely confluent, loosely covered by epidermis or naked, pulverulent, somewhat pulvinate, dark yellowish-brown. Uredospores, broadly ellipsoidal, subglobose or globose, densely echinulate (distances between spines about 2–3μ), 24–30 × 18–25μ; epispore brownish yellow, 2–3μ thick; germ-pores 2, equatorial, inconspicuous; paraphyses absent in the sori.

Hab. On *Oplismenus compositus* Beauv.

Loochoo.—Shuri (II. & III. Nov. 27, 1898. N. HIRATSUKA).

Formosa.—Daihoku (II. Nov. 17, 1906. T. KAWAKAMI & R. SUZUKI).

Distrib. India and Japan.

REMARKS. The species belonging to this genus are generally found in the tropical or subtropical regions of Asia, Africa and America. The total number of the species is not abundant.

In Japan, the presence of the species of this interesting genus have remained unknown up to this time. We have in our University Herbarium, two specimens of the present species collected in Formosa and Loochoo on *Oplismenus compositus*. Our species coincides exactly to the description of the fungus by SYDOW and BUTLER (2) in the characters of teleutospores.

The authors did not describe the uredostage of this fungus, which I take pleasure in supplementing in this paper.

STEREOSTRATUM Magnus.

1. Stereostratum corticioides (Berk. et Br.) P. Magnus, in Ber. Deutsch. Bot. Ges., **17**, 1899, (178).

Syn.: *Puccinia corticioides* Berk. et Br., in Journ. of Linn. Soc., **16**, 1877, (520); Sacc., Syll., **7**, 1888, (731); Dietel, in Engl., Bot. Jahrb., **27**, 1900, (283); P. Henn., in Engl., Bot. Jahrb,, **28**, 1901, (262); **31**, 1902, (731); Hori, Bot. Mag. Tokyo., **6**, 1892, (211); in Yatabe, Icon. flor. Jap., **1**, 1892, (143); Massee, in Grev., **22**, 1893/94, (18); Sydow, Monogr. Ured., **1**, 1904, (847).

Puccinia Schotmülleri P. Henn., in Hedw., **32**, 1893, (61); Sacc., Syll., **11**, 1899, (200).

Hab. On *Arundinaria Simoni* Riv.

Honshū.—Prov. Settsu: Kōbe (III. April 28, 1875. Challenger exp.).—Prov. Musashi: Tokyo (III. March 9, 1891; III. 1895. S. HORI; III. May 10, 1902. T. NISHIDA; II. May 1904. S. KUSANO); Horinouchi (III. April 15, 1894. S. MATSUDA).

Kiushū.—Prov. Chikuzen: Kasuya-gun (III. April 19, 1905. K. YOSHINO).

On *Arundinaria Simoni* Riv. var. *Chino* Mak.

Kiushū.—Prov. Hizen: Kumamoto (III. April 27, 1905. K. YOSHINO); Prov. Hizen: Itoshima-gun (III. April 20, 1905. K. YOSHINO); Fujitsu-gun (III. April 23, 1905. K. YOSHINO).

On *Phyllostachys bambusoides* S. et Z.

Kiushū.—Prov. Hizen: Wakasugi (III. April 19, 1905. K. YOSHINO); Kasuya-gun (III. April 19, 1905. K. YOSHINO).

On *Phyllostachys puberula* Munro.

Kiushū.—Prov. Higo: Ōe-mura (III. Feb. 3, 1905. K. YOSHINO).

On *Sasa albo-marginata* Mak. et Shib.

Kiushū.—Prov. Higo: Mt. Aso (III. April 3, 1907. T. TADA).

Distrib.—Japan.

REMARKS. The present species was first collected by a botanist in the Challenger expedition at Kōbe in 1875. The specimen was sent to BERKELEY for identification. He described it in cooperation with BROOME under the name of *Puccinia corticioides* in the Journal of the Linnean Society (l. c.). But to them its uredostage was not known. In 1892, Mr. HORI (l. c.) found

that the duration of the teleutostage begins from September and lasts to the end of April, while that of the uredostage ranges from April to September. The author described accurately the characters of the uredospores. He further remarked about the variability in the shape of the teleutosorus and in the length of the pedicel of the teleutospore. The length of the pedicel differs according to the position of the spores. When they are situated in the middle part of the sorus, the length of the pedicel often reaches to 1 mm.

In 1893, P. HENNINGS (1) described the present fungus as a new species under the name of *Puccinia Schottmülleri* from the specimen collected by OTTO SCHOTTMÜLLER in Nagasaki, in 1861, on Bambusa sp. In 1894, G. MASSEE (1) observed that *Puccinia Schottmülleri* of P. HENNINGS is nothing but *Puccinia corticioides* of BERKELEY and BROOME. In 1901, P. HENNINGS (3) retracted the name of *Puccinia Schottmülleri*.

Before that time, in 1899, P. MAGNUS (1) proposed to found on it a new genus Stereostratum. He distinguished it from Puccinia by a hyaline or light colored epispore, by the number of germ-pores and by the peculiar character of the sorus of the teleutospores. The author noted its relations to Gymnosporangium, which it resembles in the hyaline wall and the shape of sorus, but it differs in the non-gelatinous character of the pedicel.

In 1875, SCHROETER established a new genus Uropyxis, laying importance on the presence of two or more germ-pores in each cell of the teleutospore. Our species may be included in Uropyxis, considering from the presence of two germ-pores and of thin hyaline membrane only, but the Stereum-like form of its sorus prevents us from doing so.

In 1904, SYDOW (2) remarked that Stereostratum ought to be included in the Uropyxis series of Puccinia.

Based on my personal observations of many specimens (1) I am inclined to accept the view of P. MAGNUS in considering our species as a type of a new genus Stereostratum. (2) The host-plant is not limited to *Arundinaria Simoni* as has hitherto been considered, but *Phyllostachys bambusoides*, *P. puberula* and *Sasa albo-marginata* are also to be counted as its host-plants.

ROSTRUPIA Lagerh.

1. Rostrupia Elymi (West.) Lagerh. in Journ. de Bot., 3, 1889, (185 ; Sacc., Syll., 9, 1891, (316).

Syn. : *Puccinia Elymi* West., in Bull. Brux., 1851, (408) ; Sacc., Syll., 7, 1888, (656).

Puccinia triarticulata Berk. et Cult., North Pacific Exped. n. 130 ; Sacc., Syll., 7, 1888, (732).

Hab. On *Elymus arenarius* L.

Hokkaidō.—Prov. Kitami : Oshidomari (III. July 21, 1899. T. KAWAKAMI) ; Kutsugata (II. & III. Sept. 2, 1899. T. KAWAKAMI) ; Wakkanai (II. & III. Aug. 17, 1894. K. MIYABE) ; Rebun-Island (III. Aug. 23, 1894. K. MIYABE) ; Rishiri-Island (II. & III. Aug. 20, 1907. M. MIURA).—Prov. Shiribeshi : Shiribetsu (II. & III. July 28, 1897. G. YAMADA) ; Kitamura (III. Sept. 1, 1905. K. MIYABE). —Prov. Iburi : Mororan (III. Aug. 3, 1900. G. YAMADA).

On *Elymus sibiricus* L.

Hokkaidō.—Prov. Shiribeshi : Shikuzushi (III. Oct. 7, 1897. K. MIYABE).—Prov. Kitami : Rishiri-Island (II. & III. Aug. 20, 1907. M. MIURA).

Distrib. Europe, North America and Japan.

REMARKS. The present genus was found by LAGERHEIM in 1889 after the name of the eminent mycologist, E. ROSTRUP.

We have in Japan three species of this genus ; viz., *Rostrupia Dietelii* Kom., *R. Elymi* and *R. Miyabeana* n. sp.

In 1851, WESTEND described for the first time *Puccinia Elymi* on *Elymus arenarius*. When comparing our species with the descriptions of the fungus, I have found two points of difference. 1. The positions of the uredosori and teleutosori are just reverse to the descriptions. 2. The teleutospores are one septated and are provided with hyaline pedicels, while in our cases they are many septated and furnished with colored pedicels.

The description of *Puccinia triarticulata* on *Elymus mollis*, collected on the American side of the Behring strait by CHARLES WRIGHT, is too brief to identify our plant with it. But from the characters there given and the relation of the localities, our fungus may safely be regarded as the same species as the Behring plant.

In 1889, LAGERHEIM united them under the present name. The fungus

is commonly found on the leaves of *Elymus arenarius*, but is also rarely found on *Elymus sibiricus* in Hokkaidō.

2. Rostrupia Miyabeana S. Itō. n. sp.—(Pl. XII. Fig. 8).

Uredosori, amphigenous, mostly epiphyllous; small, oblong or elliptical, scattered or gregarious, on the brownish discolored spots, naked, with torn epidermis, pulverulent, orange-colored. Uredospores globose, subglobose or broadly ellipsoidal, echinulate, 18–28 × 14–16μ; epispore 1–2μ or 3μ thick, hyaline or subhyaline; paraphyses absent.

Teleutosori, hypophyllous or on the sheath; small, oblong or sublinear, scattered or subgregarious, long covered by the epidermis, sometimes confluent, somewhat pulvinate, black; separated into small compartments by the thick bed of brown paraphyses. Teleutospores cylindrical or oblong-clavate, apex slightly thickened (3–5μ), truncate or obliquely pointed, rarely rounded, base attenuated or rounded, not or very slightly constricted at the septum, 2–4 septated, smooth, blackish ferruginous, darker colored at apex, 32–52 × 15–24μ; pedicels short, brown, subdeciduous.

Hab. On *Brachypodium japonicum* Miq.

Hokkaidō.—Prov. Oshima: Hakodate (II. & III. July 1897. T. Kawakami).

Kiushū.—Prov. Higo: Imizu-mura (III. June 9, 1904; II. Feb. 12, 1905. K. Yoshino).

On *Brachypodium pinnatum* Beauv.

Hokkaidō.—Prov. Ishikari: Umon (III. Aug. 11, 1891. K. Miyabe).

Distrib. Japan.

Remarks. The case of Rostrupia parasitic on the leaves of *Brachypodium* has hitherto not been recorded. In our specimen, it is true that the two-celled teleutospores are often found mixed, but the three-celled ones are far more common. The four-celled ones are comparatively few in number.

The length of the teleutospore of this fungus is shorter than that of *Rostrupia Elymi*, but its breadth is generally wider. Its color differs from that of the latter species being darker and the lowest septum is sometimes longitudinal or oblique.

UREDO Pers.

A. Paraphyses absent in the sori.

1. **Uredo Rottbœlliæ** Diet., in Engl., Bot. Jahrb., **32,** 1903, (52); **34,** 1905, (591); Sacc., Syll., **17,** 1905, (457).—(Pl. XII. Fig. 9).

Hab. On *Rottbœllia compressa* L. var. *japonica* Hack.

Honshū.—Prov. Musashi: Tokyo (H. June 22, 1896; H. Oct. 20, 1896. S. HORI; H. Oct. 23, 1899. N. NAMBU; H. Nov. 25, 1899. T. NISHIDA).

Distrib. Japan.

REMARKS. SYDOW (2) suggested that this Uredo might belong to *Puccinia Rottbœlliæ* Syd.

In 1902, ARTHUR (3) made this species synonymous to *Uromyces Rottbœlliæ* Arth. of Himalaya.

In 1906, MCALPINE (1) writes of the present species as synonymous to *Puccinia cacao* McAlp. of Australia, after the determination by DIETEL.

In our country as its teleutostage is not yet known, it is still under question, whether our species belong to *Uromyces Rottbœlliæ*, or to *Puccinia cacao* or to *Puccinia Rottbœlliæ*. But one fact is certain that our species has no amphispores, of which ARTHUR (5) writes in the case of his *Uromyces Rottbœlliæ*. In short, it seems to me safe in the present case to treat the present species as *Uredo Rottbœlliæ*.

2. **Uredo Kühnii** (Krüg.) Wak. et Went., De Ziekten van het Suikerriet op Java, 1898, (144).

Syn.: *Uromyces Kühnii* Krüg., Bericht Zuck. West-Java, 1890, (117); Sacc., Syll., **11,** 1895 (182).

Hab. On *Saccharum officinarum* L.

Formosa.—Daihoku (H. Nov. 20, 1906. T. KAWAKAMI).

Distrib. Japan, India, Java and Australia.

REMARKS. The present fungus was first described by KRÜGER (1) under the name of *Uromyces Kühnii*, which he had found parasitic on the leaves of suger cane in Java together with *Cercospora Vaginæ* Krüg.

Later, WAKKER and WENT (1) proved by the infection experiments, that the fungus lacks entirely the teleutostage and gave it the present name.

Moreover, they observed that the fungus also attacks the wild sugar cane (*Saccharum spontaneum*) in Java as well as in Australia.

In 1906, SYDOW and BUTLER (1) identified the Indian fungus on *Saccharum arundinacea*, *S. fusca* and *S. spontaneum* with the present species, and remarked that the uredospore on the last named host-plant differs from the rest by having a thickened apex.

Our specimens on *Saccharum officinarum* from Formosa, as WAKKER and WENT remarked, have the sori mostly on the leaf-blade. Macroscopical appearance also agrees with the description of these authors. They recorded the sori, however, as amphigenous, saying that those on the under surface of the leaves are more than those on the upper surface. But I have not been able to find in the Formosan specimens even a sorus on the upper surface.

I found two kinds of spores in the same uredosori. The one kind is the uredospores with equally thickened hyaline wall, and the another is those with a wall thickened especially at the apex and with brownish-yellow epispore. It is very probable that the latter sort of the spores might probably have led KRÜGER to consider this fungus to be a species of Uromyces.

3. **Uredo Yoshinagai** Diet., in Engl., Bot. Jahrb., **37**, 1906, (109).

Hab. On *Arundinella anomara* Steud.

Distrib. Japan.

REMARKS. DIETEL (9) has suggested the affinity of the present species to the uredospore of *Puccinia peridermiospora* (Ell. et Tracy) Arth. on *Spartina cynosuroides* of North America.

B. Paraphyses present in the sori.

4. **Uredo jozankensis** S. Itō. n. sp.—(Pl. XII. Fig. 10).

Uredosori, hypophyllous; very minute, oblong or ellipsoidal, on the dark brownish spots, scattered, not confluent, rarely arranged in lines, long covered by epidermis, when ruptured pulverulent, orange-colored. Uredospores globose, subglobose or piriform, echinulate, 15–20 × 14–17 μ; germpores inconspicuous; epispore yellow; paraphyses clavate, apex slightly thickened (2–3 μ), yellow-ochre colored, 28–40 × 9–14 μ.

Hab. On *Melica nutans* L.

Hokkaidō.—Prov. Ishikari: Jōzankei (II. Aug. 22, 1898. K. MIYABE; II. Aug. 24, 1898. T. NISHIDA); Yamahana (II. Sept. 15, 1907. S. ITŌ); Maruyama (II. Sept. 22, 1907. S. ITŌ).

Distrib. Japan.

REMARKS. Compared with *Puccinia Melicæ* of Europe, our species resembles it very closely in the remarkably small size of their uredospores. But they differ from each other in the fact that in our species there are yellow-ochre colored clavate paraphyses, although few in number, while ERIKSSON particularly laid stress on the absence of paraphyses in the sori of *Puccinia Melicæ*.

5. **Uredo Bromi-paucifloræ** S. Itō. n. sp.—(Pl. XII. Fig. 13).

Uredosori, epiphyllous; minute, oblong or sublinear, scattered or gregarious, often confluent, naked, with ruptured epidermis, pulverulent, brownish yellow. Uredospores, globose or broadly ellipsoidal, echinulate, yellow or brownish yellow, 20–32 × 20–28μ; epispore thin; germ-pores 6–8 (rarely 10); paraphyses numerous, clavate, hyaline, apex not thickened, 44–86 × 14–22μ.

Hab. On *Bromus pauciflorus* Hack.

Hokkaidō.—Prov. Oshima: Kamiiso (II. July 12, 1890. K. MIYABE).

REMARKS. Although there are many species of Puccinia known to be parasitic on *Bromus*, yet *Puccinia coronata* is the only species that has the paraphyses in the uredosori. While our species has numerous germ-pores, *Puccinia coronata* only 3 or 4. Moreover, the shape of their paraphyses are quite different.

The present species seems to agree *Puccinia gibberosa* on *Festuca* which is closely related in its systematic position to *Bromus*.

6. **Uredo Polliniæ-imberbis** S. Itō. n. sp.—(Pl. XII. Fig. 11).

Uredosori, hypophyllous; minute, roundish or oblong, on brownish spots, scattered or gregarious, sometimes confluent, naked, pulverulent, inconspicuous, orange-colored. Uredospores, globose, subglobose or piriform, densely echinulate, yellow or yellowish-brown, 20–26 × 16–24μ; epispore thin; germ-pores 5–9, rarely 11, scattered irregularly; paraphyses numerous,

irregularly bent, apex thickened (6–8μ), 30–48 × 10–14μ, light yellow in color.

Hab. On *Pollinia imberbis* Nees. var. *Willdenowiana* Hack.

Formosa.—Daihoku (H. Oct. 11, 1906; T. Kawakami & R. Suzuki).

Distrib. Japan.

Remarks. There are three species of Puccinia known at present to be parasitic on *Pollinia*. They are *Puccinia Eulaliæ*, *P. Polliniæ* and *P. æstivalis*.

Puccinia Eulaliæ and *P. æstivalis* have already been found in our country and the uredospores and paraphyses differ entirely from those of this species. Now, when comparing the present species to *Puccinia Polliniæ*, I noticed two points of difference between them. (1) Our species has numerous germ-pores while they are three in the case of *Puccinia Polliniæ*. (2) Paraphyses are irregularly bent in our species, while they are capitate in *Puccinia Polliniæ*. I shall call this species provisionally under the present name until its teleutospores will be found.

7. Uredo inflexa S. Itō. n. sp.—(Pl. XII. Fig. 12).

Uredosori, hypophyllous; minute, roundish or oblong, on discolored spots, scattered or subgregarious, sometimes confluent, naked, pulverulent, brownish yellow. Uredospores, broadly ellipsoidal, subglobose or piriform, echinulate, 28–40 × 20–26μ; paraphyses numerous, curved, clavate, light yellowish, 40–45 × 5–9μ.

Hab. On *Sasa sp.*

Formosa.—Daihoku (H. R. Suzuki).

Distrib. Japan.

Remarks. Among the description of the uredosori of many Puccinia on Bambuseæ, that of *Puccinia melanocephala* Syd., of India approaches most closely to the present Uredo. But as our species is still lacking its teleutostage, the exact identification can hardly be made. But the uredosori are amphigenous in the Indian species, while they are all hypophyllous in ours. The epispore is a little thinner in our species. The paraphyses are curved in ours. I shall call the fungus under consideration by the present name, until its other stages will be found.

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„ *Hierochloæ* n. sp. — *Hierochloe borealis* Rœm; *Stipa sibirica* Lam.

„ *himalensis* (Barcl.) Diet. — *Brachypodium japonicum* Miq.; „ *silvaticum* Beauv.

„ *ishikariensis* n. sp. — *Molinia japonica* Hack.

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„ *kozukensis* Diet. — *Andropogon micranthus* Kth.

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„ *Kusanoi* Diet. var. *Azuma* Kusano — „ *ramosa* Mak. et Shib.

„ *Lolii* Niels. — *Avena fatua* L.; „ *sativa* L.; „ *sterilis* L.

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„ *mitriformis* n. sp.	*Sasa paniculata* Mak. et Shib.
„ *Miyoshiana* Diet.	*Spodiopogon cotulifer* Hack. „ *sibiricus* Trin.
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„ *oahuensis* Ell. et Ev.	*Panicum sanguinale* L.
„ *okatamaensis* n. sp.	*Phragmites communis* Trin.
„ *perplexans* Plowr.	*Ranunculus acer* L. (I) „ *acer* L. var. *Steveni* Rgl. (I)
„ *persistens* Plowr.	*Thalictrum minus* L. (I)
„ *pertenuis* n. sp.	*Calamagrostis arundinacea* Roth. var. *nipponica* Hack.
„ *Phlei-pratensis* Eriks. et Henn.	*Phleum pratense* L.
„ *Phyllostachydis* Kusano	*Phyllostachys bambusoides* S. et Z. „ *bambusoides* S. et Z. var. *aurea* Mak. „ *bambusoides* S. et Z. var. *Marliacea* Mak. „ *bambusoides* S. et Z. forma *Kashirodake* Mak.
„ *Phragmitis* (Schm.) Kœrn.	*Phragmites communis* Trin. *Rumex domesticus* Hartm.
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„ *purpurea* Cke.	*Andropogon Sorghum* Brot. var. *vulgaris* Hack.
„ *rangiferina* n. sp.	*Calamagrostis arundinacea* Roth. var. *sciuroides* Hack.

Puccinia rufipes Diet.	*Imperata arundinacea* Cyr. var. *Kœnigii* (Benth.) Hack.
„ *Sasæ* Kusano.	*Sasa borealis* Mak. et Shib.
„ *sessilis* Schneid.	*Phalaris arundinacea* L.
„ *simplex* (Kœrn.) Eriks. et Henn.	*Hordeum sativum* Jess.
„ *stichospora* Diet.	*Calamagrostis arundinacea* Roth. var. *sciuroides* Hack.
„ *Stipæ-sibiricæ* n. sp.	*Stipa sibirica* Lam.
„ *Symphyti-Bromorum* Fr. Müll.	*Bromus pauciflorus* Hack.
„ *triticina* Eriks.	*Triticum vulgare* Vill.
„ *Zoysiæ* Diet.	*Zoysia pungens* Willd. var. *japonica* Hack.
Rostrupia Elymi (West.) Lagerh.	*Elymus arenarius* L. „ *sibiricus* L.
„ *Miyabeana* n. sp.	*Brachypodium japonicum* Miq. „ *pinnatum* Beauv.
Stereostratum corticioides (Berk. et Br.) P. Magnus.	*Arundinaria Simoni* Riv. „ *Simoni* Riv. var. *Chino* Mak. *Phyllostachys bambusoides* S. et Z. „ *puberula* Munro. *Sasa albo-marginata* Mak. et Shib.
Uredo Bromi-paucifloræ n. sp.	*Bromus pauciflora* Hack.
„ *inflexa* n. sp.	*Sasa sp.*
„ *jozankensis* n. sp.	*Melica nutans* L.
„ *Kühnii* (Krüg.) Wak. et Went.	*Saccharum officinarum* L.
„ *Pollinieæ imberbis* n. sp.	*Pollinia imberbis* Nees. var. *Willdenowiana* Hack.
„ *Rottbœlliæ* Diet.	*Rottbœllia compressa* L. var. *japonica* Hack.
„ *Yoshinagai* Diet.	*Arundinella anomala* Steud.
Uromyces Alopecuri Seym. var. *japonica* n. var.	*Alopecurus fulvus* L. „ *japonicus* Steud.
„ *coronatus* Miy. et Nish.	*Zizania aquatica* L.
„ *Muehlenbergiæ* n. sp.	*Muehlenbergia japonica* Steud.
„ *ovalis* Diet.	*Leersia oryzoides* Sw. var. *japonica* Hack.
„ *Setariæ italicæ* (Diet.) Yoshino.	*Setaria italica* Beauv. var. *germanica* Trin. „ *viridis* Beauv.

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Explanation of Figures.

All figures are drawn to the same magnification (×390) using a camera-lucida and Zeiss's objective D and ocular 4.

Plate X.

Fig. 1. *Uromyces ovalis* Diet. on *Leersia oryzoides* Sw. var. *japonica* Hack.
Fig. 2. „ *coronatus* Miyabe et Nishida, on *Zizania aquatica* L.
Fig. 3. „ *Alopecuri* Seym. var. *japonica* n. var. on *Alopecurus fulvus* L.
Fig. 4 „ *Setariae italicae* (Diet.) Yoshino, on *Setaria italica* Beauv. var. *germanica* Trin.
Fig. 5. „ *Muehlenbergiae* n. sp. on *Muehlenbergia japonica* Steud.
Fig. 6. *Puccinia Diarrheniae* Miyabe et Itō. n. sp. on *Diarrhena japonica* Fr. et Sav.
Fig. 7. „ *brevicornis* n. sp. on *Calamagrostis villosa* Mut.
Fig. 8. „ *Epigejos* n. sp. on *Calamagrostis Epigejos* Roth. var. *densiflora* Led.
Fig. 9. „ *pertenuis* n. sp. on *Calamagrostis nipponica* Fr. et Sav.
Fig. 10. „ *Hierochloae* n. sp. on *Hierochloe borealis* Roem.
Fig. 11. „ *Hierochloae* n. sp. on *Stipa Sibirica* Lam.
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Fig. 13. „ *coronata* Cda. on *Calamagrostis arundinacea* Roth. var. *sciuroides* Hack.

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Fig. 2. „ *Glyceriae* n. sp. on *Glyceria aquatica* Sm.
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Fig. 6. „ *ishikariensis* n. sp. on *Molinia japonica* Hack.
Fig. 7. „ *fujiensis* n. sp. on *Anthoxanthum japonicum* Hack.
Fig. 8. „ *culmicola* Diet. on *Brachypodium japonicum* Miq.
Fig. 9. „ *culmicola* Diet. on *Agropyrum caninum* Beauv.
Fig. 10. „ *Nakanishikii* Diet. on *Andropogon Nardus* L. var. *Goeringii* Hack.
Fig. 11. „ *Arundinellae anomalae* Diet. on *Arundinella anomala* Steud.
Fig. 12. „ *erythropus* Diet. on *Miscanthus sinensis* Anders.

Plate XII.

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Fig. 2. „ *okatamaensis* n. sp. on *Phragmites communis* Trin.
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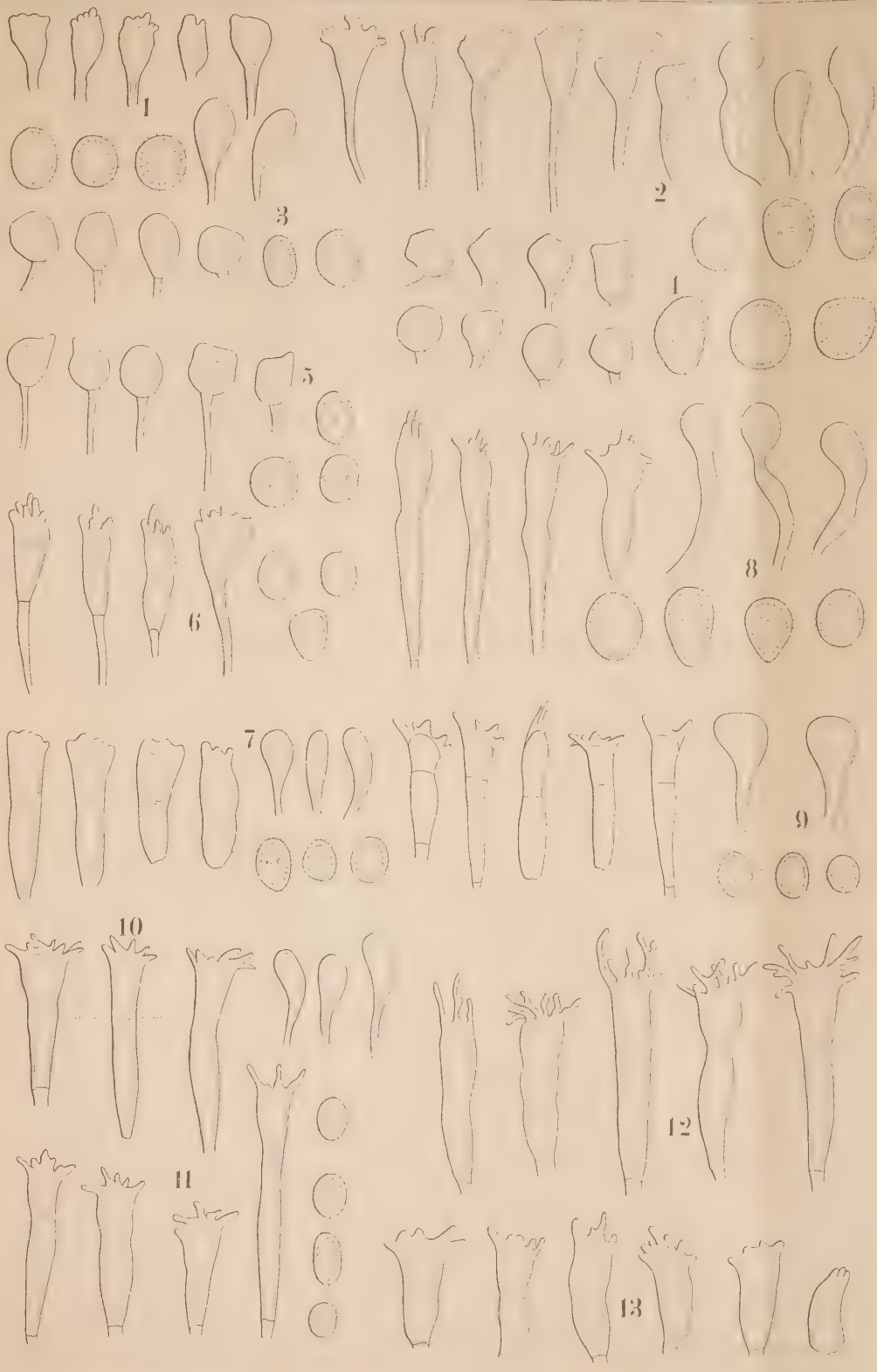
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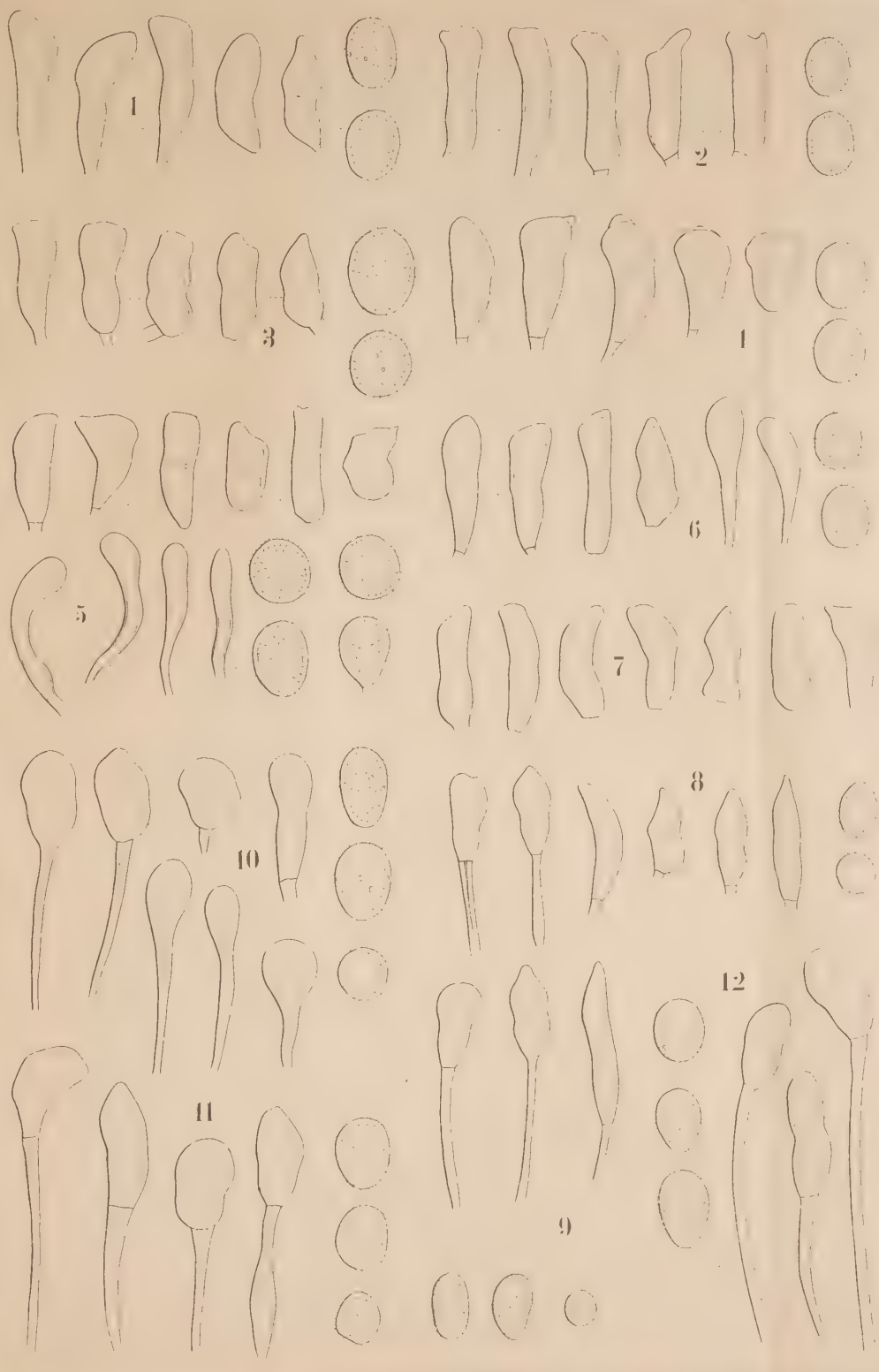
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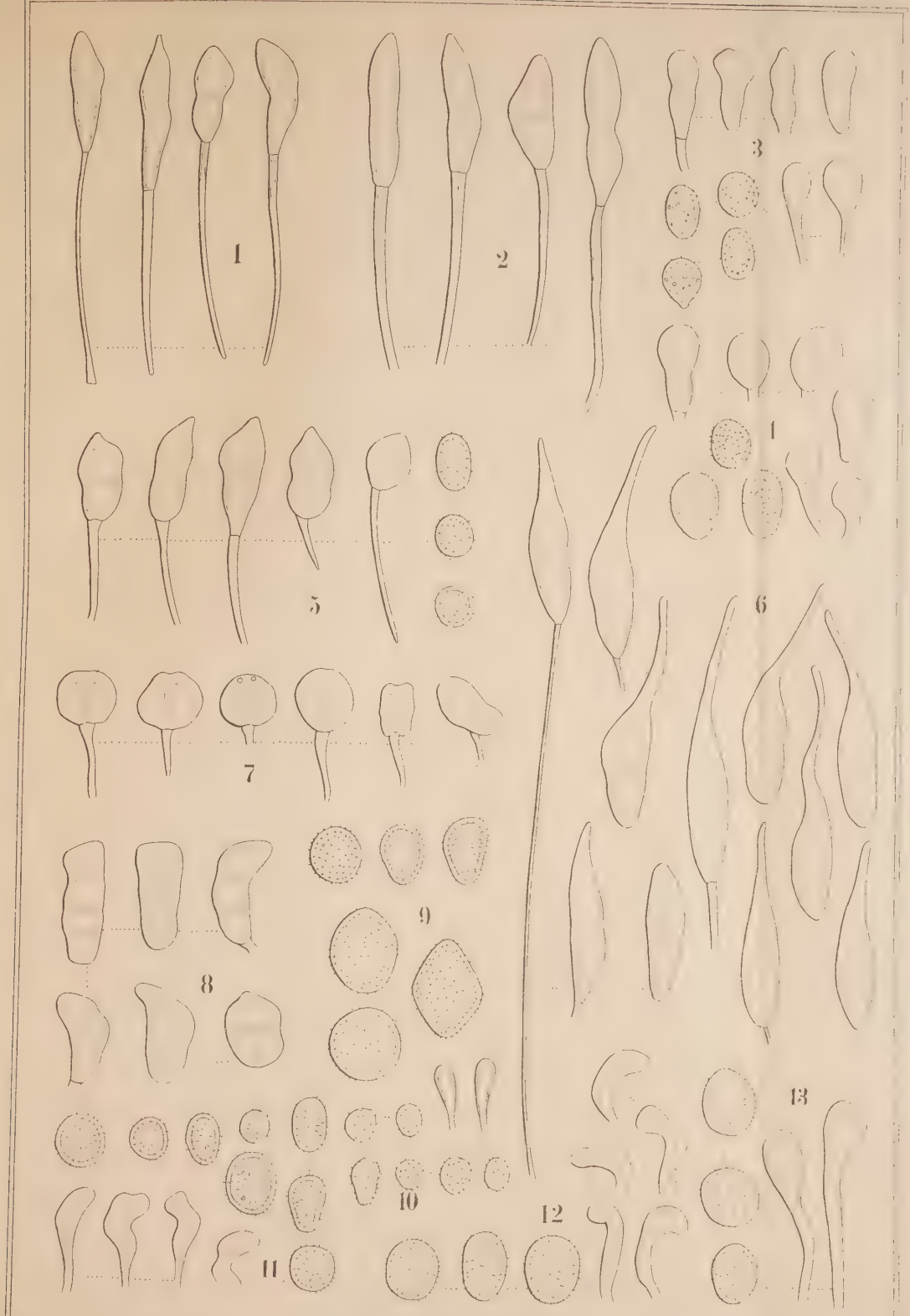

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